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SOME NOTES ON ORIENTAL WATER-WORKS.*

By GEORGE A. JOHNSON.†

During a recent trip around the world the author made a somewhat extended study of numerous Oriental water-works. It would be out of place in a paper of this character to go much into detail or to attempt a complete description of all the works visited. In this article, therefore, will be given as briefly as possible the more salient features of Japanese water-works, and of the works at Shanghai, China, Singapore, Straits Settlements and Bethmangala and Calcutta, India.‡

THE WATER-WORKS OF JAPAN.

There have been public water supplies of a kind in Japan since the year 1600, when Iyeyasu, founder of the Tokugawa dynasty of Shoguns, inaugurated the first public water supply at Tokyo. These original works were remodelled and improved some 65 years later, and were improved and extended many times during the next two centuries. It was not until 1892, however, that the present modern and efficient works were put under construction, and it was 1898 before they were completed.

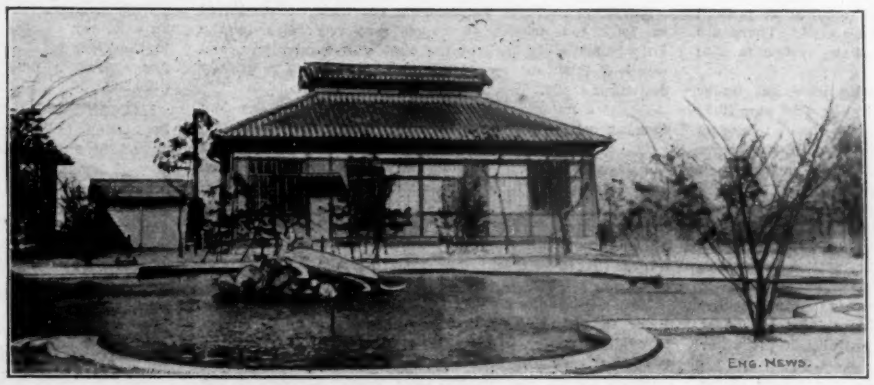
To Yokohama‖ belongs the credit for having installed the first modern system of water-works in Japan. Construction of these works was begun in 1885. In 1880 the construction of the Nagasaki water-works was begun.

Osaka commenced her works in 1892, Hiroshima in 1896, Kobe in 1897, Hakodate in 1898, Shimonoseki and Okayama in 1900 and Akita in 1903. In all, therefore, there are 10 cities in Japan provided with public water supplies, nine of which filter the water before delivery to the consumers, the Hakodate supply being unfiltered. In addition to these 10 cities there are Kamiura, Sawarazawa and Iizuka, towns with populations of 2,165, 1,396 and 1,240, respectively, which have public supplies, that of one, Kamiura, being filtered.

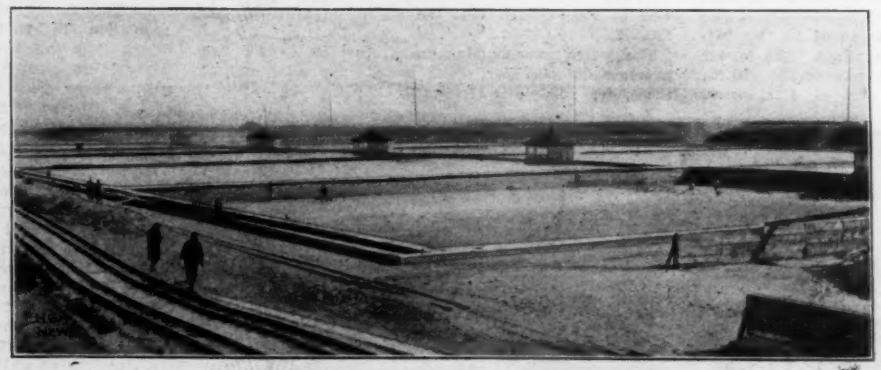
The total population of the 13 cities and towns which have public water supplies is in round numbers about 4,100,000, and of this number roughly 4,000,000 are supplied with filtered water. In general terms about one-third of all service lines are metered, and there is a fire hydrant provided to about every 50 houses. The average daily water consumption is about 25 gals. per capita. The total capital cost of all existing Japanese water-works systems to date is in round numbers $11,500,000, or $2.80 per capita.

TOKYO.—Construction work was begun in 1892 and the works were first put into commission in 1898. In 1904 the population of Tokyo was 1,870,628.

The intake is located on the Tama River, at Hamura, and from there to the present works the water flows by gravity through about 30 miles of open and closed canal. On reaching the works at Yodobashi the water passes through sedimentation basins, three in number, each 720 × 360 ft. × 19.5 ft. deep, having a total capacity of 67,300,000 gals. These basins may be worked intermittently or continuously, and when operating as continuous flow basins the period of sedimentation is equal to about 36 hours, and the velocity of flow through them to about 0.067-in. per sec.



WATER-WORKS LABORATORY, OSAKA, JAPAN.



GENERAL VIEW OF FILTERS, OSAKA, JAPAN.

From the sedimentation reservoirs the clarified water flows through regulated outlets onto slow sand filters, of which there are 18 one-acre units. The sand layers are 30 ins. in depth and are supported by 24 ins. of graded underdraining material. The filters are operated at a rate of 2,933,000 gals., corresponding to a total gross capacity for the 18 filters of 52,794,000 gals. daily.

The filters require scraping about seven times a year on an average. At such times the dirty sand is removed from the beds, dumped into cement-lined troughs, water applied and the sand agitated by coolies with rakes until clean.

There are three 7,500,000-gal. filtered-water basins, all covered, corresponding to a total storage capacity of about 12 hours.

Two-thirds of the supply is delivered by gravity to the low level districts. The remaining one-third is pumped at the Yodobashi station by means of four 300-HP. pumping units, each of a capacity of 7,500,000 gals. per day when working against a head of from 80 to 100 ft.

The charges for water vary, according to the use to which it is put, from 6 to 10 cts. per 1,000 gals. The water is of excellent quality, clear, soft and without noticeable color. At the present time there are 85,539 services and 5,177 fire hydrants. The metered services number 20,514. The water consumption ranges from 11 to 23 and averages 17 gals. per capita daily. The total cost of the works to date is $4,250,000.

OSAKA.—The Osaka water-works were put under construction in 1892, and originally designed to serve a population of 600,000. They were later extended to serve a population of 800,000. The population of Osaka in 1904 was 1,026,767.

The supply is derived from the Yodo River, from whence it is raised by three centrifugal pumps to a series of four settling basins against a total head of about 30 ft. After 36 hours sedimentation the water is applied to slow sand filters and then pumped by seven triple-expansion pumping engines of the Worthington type to the 3,750,000-gal. distributing reservoir at Osaka Castle against a total head of about 130 ft. [A view of the water-works laboratory is shown by Fig. 1 and a general view of the filters by Fig. 2.]

The raw river water has a turbidity ranging from 10 to 350 parts per 1,000,000. There will be about 20 days in the average year when the turbidity of the raw water will be over 100 parts per 1,000,000, and about 50 days when it will be over 50 parts. The alkalinity averages about 20 parts per 1,000,000, and the number of bacteria ranges from 40 to 30,000 and averages about 2,000 per c.c.

The settling reservoirs, four in number, are each 330 × 360 ft. × 12 ft. effective depth. Their combined effective capacity is 12,600,000 gals. The sediment in these basins is flushed out once annually, when between 3 and 4 ins. or about 5,200 cu. yds. are removed. The cost of labor for flushing out this material is 2 cts. per cu. yd.

The filters are of the slow sand type, eleven in number, ten of which are 151 × 182 ft., and one 182 × 350 ft. The total filtering area is therefore 7.77 acres. The tanks are of concrete and brick and the filter finished in 1903, 182 × 350 ft. × 7.5 ft. deep, cost $40,700 or $27,840 per acre, exclusive of the filtering material, which cost about $3,000 per acre additional.

The filters are operated in an up-to-date manner, although the rate of filtration is not automatically controlled and fluctuates with the pumpage. The average actual rate of filtration is 2,900,000 gals. per acre daily.

*Slightly condensed from a paper read before the American Water-Works Association, July, 1907.

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‡For their great kindness in aiding the writer in his endeavor to obtain information upon the works described, hearty acknowledgments are due to Dr. Y. Nakajima of Tokyo; Mr. S. Inoue and Dr. S. Tanabe of Kyoto; Mr. Z. Mita of Yokohama; Mr. K. Funabiki; Mr. H. Ono, Mr. K. Inouye and Mr. Y. Tsujimura, of Osaka, Japan; Mr. McLeod and Mr. Mollison of Shanghai, China; Mr. Pierce of Singapore, Straits Settlements; Mr. Fogarth of Bethmangala ,and Mr. McCabe and Mr. Peirce of Calcutta, India.

‖For the data from which the following digest of modern water-works practice in Japan has been prepared the writer is indebted to his friend, Mr. S. Inoue, Chief Engineer of Kyoto Municipality, Japan, and a member of this Association.

The net rate is equal to about 2,600,000 gals. per acre daily.

Each filter requires scraping about twice a month on an average, and at such times about 1-3-in. of material is removed. The sand removed is used for filling. A gang of coolies [Figs. 3 and 4] is kept busily engaged at the river bank practically all of the time screening sand, which is hand dredged from the bed of the Yodo River opposite the water-works, brought to the shore in boats and there sun dried and pan screened.

The water rates vary from 10 to 60 cts. and average about 20 cts. per 1,000 gals. The filtered water is of excellent quality, has an alkalinity of about 20 parts per 1,000,000, and during the year 1905 contained the average number of 25 bacteria per c. c. There are at present 48,513 services, of which 9,369 are metered. There are 3,000 fire hydrants. The total cost of the system to date is $1,653,020.

FIG. 3. REMOVING SAND FROM DEEPLY CLOGGED BED.

Fig. 4. Carrying Off Dirty Sand.

FIGS. 2 AND 3. CLEANING FILTER BEDS AT OSAKA, JAPAN.

YOKOHAMA.—The Yokohama works were put under construction about 22 years ago, when the first pipe lines were laid from the Sagami River. The new intake is located on the Doshi River, near the foot of Fujiyama, and from there to the site of the filtration works on Nogiyama, a distance of some 30 miles, the water flows by gravity.

The works were originally designed to serve a population of 70,000, and have since been extended to serve 300,000 people. In 1904 the population of Yokohama was 331,597.

The raw water of the Doshi River is normally clear and noticeably free from color and turbidity except at times following heavy rains. The alkalinity of the water is about 27 parts per 1,000,000.

On reaching the filtration works the four supply mains discharge into two small receiving wells, provided with suitable regulating devices to maintain a constant water level on the filters.

The slow sand filter beds are arranged in two batteries, one of four and one of two filters. The former are each 120 × 70 ft., and the latter are each 120 × 80 ft.; corresponding to a total filtering area of 1.212 acres.

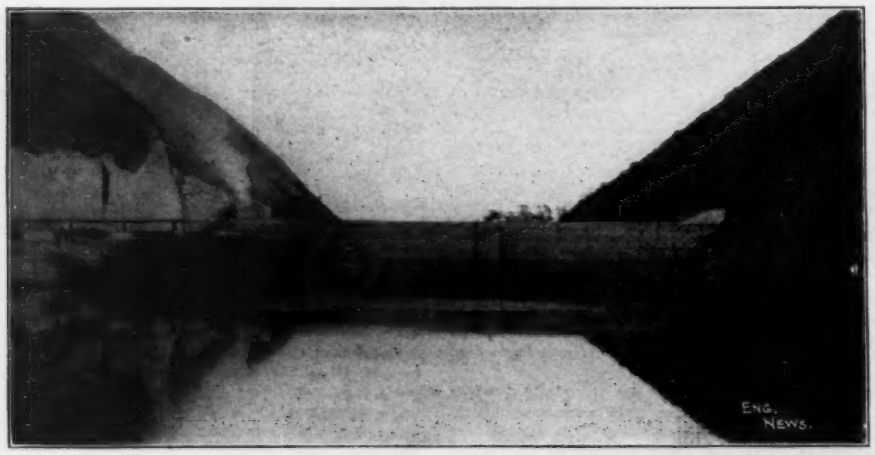

FIG. 5. DAM FORMING IMPOUNDING RESERVOIR, KOBE, JAPAN.

The sand layer is 2.5 ft. thick, supported on a layer of graded underdraining material 18 ins. in depth. The sand is of medium size, rather dark in color, and of good stable quality. It costs about $2.75 per cu. yd., in the filters.

The filters are operated at the somewhat high rate of 6,530,000 gals. per acre daily, and require scraping about once a month. Sand-washing procedures are similar to those employed at the Tokyo water-works.

There are two baffled clear water basins, each covered, having a total capacity of 3,192,000 gals., corresponding to a storage of practically 12 hours' supply.

The filtered water is high grade, clear, soft and colorless, and stands in enviable repute among the citizens of Yokohama. The works are well built and well operated. There are at present 2,745 metered and 7,679 unmetered services. There are 1,236 fire hydrants, or one to every 50 houses. The consumption ranges from 19 to 29, and averages 24 gals. per capita daily. The total cost of the system to date is $1,548,140.

KOBE.—The Kobe works were put under construction in 1897 and consist of impounding reservoirs in the hills immediately back of the city, slow sand filters, and small distributing reservoirs. The system is a gravity one throughout.

The two impounding reservoirs [Fig. 5 shows the dam forming one of these] have a total capacity of 483,000,000 gals., corresponding to a storage of 140 days' supply at the average rate of consumption of 3,480,000 gals. daily. The drainage area is mountainous and sparsely populated.

The raw water, owing to the lengthy period of storage allowed, is never excessively muddy when applied to the filters. It is soft and free from noticeable amounts of color.

The eleven filters have a total area of 3.04 acres. Prior to its application to the filters the water passes through a 1,000,000-gal. settling reservoir. The five distributing basins have a total capacity of 260,000 gals.

There are at the present time 11,581 services in the city, 2,576 of which are metered. There are 1,173 fire hydrants. The works were designed to serve a population of 250,000. In 1904 the population of Kobe was 295,276.

The water consumption ranges from 20 to 40, and averages 30 gals. per capita daily. The total cost of the system to date is $1,468,640.

NAGASAKI.—These gravity works were put under construction in 1889, and consist of impounding reservoirs, slow sand filters and distributing reservoirs. The original works were designed to serve a population of 60,000, but have since been extended to serve 182,000. In 1904 the population of Nagasaki was 159,041.

The three impounding reservoirs have a total storage capacity, at a daily average consumption of [illegible] gals., sufficient for 293 days' supply, or a total of 493,000,000 gals. From the storage reservoirs the water flows to nine slow sand filters, having a total area of 2.36 acres. From the filters the water flows to four clear water basins, having a total capacity of [illegible] gals.

At the present time there are 5,901 services in the city, 953 of which are metered. There are 492 fire hydrants. The total cost of the system to date is $788,080.

HIROSHIMA.—Construction work was begun in 1896. Population in 1904 was 127,117. The works were designed to serve a population of 120,000. The source of water supply is the Ota River. There are two settling basins, with a total capacity of 1,200,000 gals. The four slow sand filters have a total area of 1.75 acres. The two clear water basins have a total capacity of 950,000 gals. Water consumption ranges from 15 to 40, and averages 28 gals. per capita. There are at present 6,693 services in the city, 1,610 of which are metered. There are 709 fire hydrants. The total cost of the system to date is $465,560.

SHIMONOSEKI.—Construction work was begun in 1900. Population in 1904 was 46,905. The works were designed to serve a population of 60,000. The supply is derived from small mountain streams. The impounding reservoir has a capacity of 286,000,000 gals. There are three slow sand filters with a total area of .87-acre. There are two clear-water basins with a total capacity of 270,000 gals. Distribution is by gravity. Total cost of the works to date is $449,080.

OKAYAMA.—Construction work was begun in 1900. Population in 1904 was 81,324. The source of supply is the Asahi River. There are two settling basins, with a total capacity of 3,000,000 gals. There are four slow sand filters, with a total area of 1.31 acres. There are two clear water basins with a total capacity of 810,000 gals. The total cost of the system to date is $401,900.

AKITA.—Construction work was begun in 1903. The population in 1904 was 33,695. The supply is drawn from the Asahi River, a branch of the Omono River. The settling basin has a capacity of 1,000,000 gals. There are two slow sand filters, with a total area of .66-acre. The capacity of the clear water basin is 750,000 gals. The total cost of the system to date is $235,150.

HAKODATE.—Construction work was begun in 1898. Population in 1904 was 88,071. The works were originally designed to serve a population of 60,000, but have since been extended to serve a population of 150,000. The supply is drawn from the Aka River. The storage reservoir has a capacity of 1,530,000 gals. The water is not filtered. There are two distributing reservoirs, the total capacity of which is 1,920,000 gals. The daily water consumption ranges from 22 to 35, and averages 26 gals. per capita. There are at present 2,500 services in the city, 729 of which are metered. There are 110 fire hydrants. The total cost of the works to date is $229,310.

SAWARAZAWA.—Construction work was begun in 1898. Population in 1904 was 1,396. The supply is drawn from small mountain streams. The impounding reservoir has a capacity of 300,000 gals. The water is distributed by gravity direct from this reservoir to the consumers. The total cost of the works to date is $5,000.

IIZUKA.—Construction work was begun in 1903. Population in 1904 was 1,240. The supply is drawn from mountain streams. The impounding reservoir, from which the water is distributed direct by gravity to the consumers, has a capacity of 200,000 gals. The total cost of the works to date is $4,090.

KAMIURA.—Construction work was begun in 1900. Population in 1904 was 2,165. The source of water supply is the Ushimaki River. The water is applied direct

to a small sand filter (area, .017-acre). The clear water basin has a capacity of 22,000 gals. The total cost of the works to date is $3,410.

OTHER ORIENTAL WATER-WORKS.

SHANGHAI, CHINA.—Shanghai is located on the east coast of China, south of the Yellow Sea, and near the mouth of the Yang-tse-Kiang. It has a population of about [illegible]. The water-works were built with the particular object in view of supplying the foreign population of that city with pure water. The total number of people tributary to these works at present is in round numbers 45,000, of which about 12,000 are of English and American birth and the remainder Chinese.

The water supply is drawn from the Hwang-poa River, the waters of which are normally very turbid, as is the case with all rivers emptying into the Yellow Sea. In fact, it is the excessive muddiness of such waters as those of the Yang-tse-Kiang and Hwang-ho that gives the name to the Yellow Sea, the waters of which are colored a deep yellow for more than a hundred miles from the mainland of China.

The raw water is raised from the river by two centrifugal pumps of local make and discharged through two 20-in. pipes into the settling basins. These basins are four in number and provide a period of sedimentation of about 25 hours.

From the settling basins the water is applied to 12 slow sand filters, with areas ranging from 1-6 to 1-3-acre [see Fig. 6]. Considerable fine clay remains in suspension even after a preliminary sedimentation of 25 hours, and the filters require scraping at intervals of one month or less.

Passing the filters the water flows to a clear water reservoir having a capacity of 6,000,000 gals., and is pumped therefrom through one 25-in. and two 20-in. mains to the consumers. The daily pumping ranges from 5,000,000 to 7,000,000 gals. The construction work in this plant is high grade, and the filters are very efficient, notwithstanding the fact that they are somewhat overworked at times.

SINGAPORE.—Singapore is located on the island of Singapore, at the southern extremity of the Malay Peninsula. The island is about 250 sq. mi. in extent, and is separated from the mainland by the narrow Straits of Tebrau. The population of the city is estimated at 200,000.

The water supply is derived from small jungle streams, which drain about 28 sq. mi. The storage reservoir is located on Thomson Road, a short distance outside the city, and has a capacity of about 1,000,000,000 gals. The raw water is not particularly turbid, but is always highly colored. Much of the time the water has a strong fishy odor, and to the taste is often highly objectionable.

The raw water flows from the storage reservoir by gravity to the outskirts of the city, where the filtration works are located. The filters are of the slow sand type, eight in number, with a total filtering area of two acres [see Figs. 7 and 8]. Operation is intermittent; that is, the beds are allowed to rest empty about 12 hours in every one to two weeks, the length of the operating period varying according to the season. By this procedure it is understood that a considerable degree of success has been achieved in removing the objectionable tastes and odors from the water, although at the time of the writer's visit—July, 1906—the filtered water had a pronounced "fishy" odor. The actual rate of filtration is said to be about 1,050,000 gals. per acre in 24 hours, corresponding to a daily yield of about 2,100,000 gals. for the eight filters. The average daily consumption is said to be about 5,000,000 gals.

BETHMANGALA, INDIA.—These works were constructed in 1903-4 for the purpose of supplying the Kolar Gold Fields with pure water. The gold fields are located in the State of Mysore, in southern India, and about 60 miles from Bangalore. The water-works are located just outside the village of Bethmangala, and about seven miles from the gold fields. Up to the time of installing the present works the water supplied to the laborers at the mines was of extremely poor quality and very scarce, a small given amount being allowed each laborer daily. These laborers are chiefly natives, but there are also, it is understood, some 800 English miners among the 20,000 workers at the mines.

The water supply is derived from the Palar River, upon which the large storage reservoir at Bethmangala, together with many similar reservoirs used chiefly for irrigation purposes, is located. The capacity of this reservoir is 1,737,612,000 gals., sufficient at a daily consumption of 2,400,000 gals. for 724 days' supply. The rainfall at Bethmangala averages only about 17 ins. annually, and the raw water is deeply colored and at times is high in suspended matter.

As to the filtration and distributing system,* the raw water is raised by two low-lift pumps to the 400,000-gal. coagulating basin. The coagulant (sulphate of alumina) feed enters the raw-water pipe leading from the low-lift pumps to the coagulating basin. After four hours' continuous coagulation and subsidence the water passes over outlet weirs into the supply pipe leading to filters of the American type. Passing the filters, it is discharged through Weston automatic controllers into a flume and thence into the covered clear water basin, being raised thence by high-lift pumps through a 16-in. main to the Kolar Gold Field, against a total head of about 500 ft.

The filters are of the Jewell gravity type, circular in plan and built of granite masonry. Over the manifold collecting system is placed a thin layer of gravel surmounted by 3.5 ft. of fine sand. Each filter has a rated capacity of 620,000 gals., corresponding to a total capacity for the four filters of 2,480,000 gals. per 24 hrs. The rate of filtration is automatically controlled by means of Weston effluent controllers.

There are two low-lift pumping outfits with a total capacity of 5,280,000 gals. per 24 hrs., and three high-lift outfits of the Worthington type of a total capacity of 3,600,000 gals. per 24 hrs. There is also a centrifugal pump for washing the filters having a capacity of 2,000 gals. per min. The last-named is belt-driven by a Pelton wheel operated with water from the 16-in. high-pressure main.

There is a tank at Champion Reefs Mine in the gold fields, built of brick laid in cement mortar. All the filtered water is pumped to this tank, from which lead branch lines to similar tanks located at the different mines, and to the service reservoir at Robertsonpet, a town about a mile distant.

The filtration works were designed by Mr. Edmund B. Weston, and built by the Jewell Export Filter Co., for whom Mr. R. W. Lawton acted as Superintendent of Construction. The amount of money appropriated for the work was $324,000.

Since the works were completed periodic analyses of the raw water and filtered water have been made by the official bacteriologist of the Mysore Government. The average results of the test made during the period Sept. 8-11, 1906, the last results available to the writer at this time, showed 4,350 bacteria per c. c. in the raw water and 13 in the filtered water. Cholera, which prior to the installation of these works was very prevalent, has been practically absent among the employees of the mines since the works were put in operation. The filter plant itself is a model of neatness, and is operated in the most intelligent, painstaking and efficient manner.

CALCUTTA.—Calcutta is located in the Province of Bengal, on the right bank of the Hugli River, and about 45 miles inland from the Bay of Bengal. The present population is estimated at 1,100,000.

The Hugli River, from which Calcutta derives its water supply, is the most western branch of the Ganges. The drainage area of the Hugli is about 25,000 sq. mi., although in addition to the runoff of this area considerable excess flow from the Ganges enters the Hugli during July, August and September.

The waters of the Hugli River are normally very muddy, and at times, especially in the rainy season, excessively so. A better idea of the effect on the muddiness of the water produced by the heavy rains which occur in the rainy season may be had from the statement that, while the average rainfall in this vicinity amounts to only about 60 ins. annually, as much as 40 ins. has fallen in a single week, and in 1900 the rainfall on two successive days was 14.5 and 10.8 ins.

The river water at the intake at Palta is subject to tidal influences. During the dry season, namely, February to June, the water is quite brackish for a part of practically every day, necessitating a cessation in pumping for substantially one-half of the time.

The original works were put under construction in 1867, greatly enlarged in 1888, and now consist of two pumping stations for raising the water from the river, settling reservoirs, slow sand filters, and gravity conduits to a reservoir on the outskirts of the city. Auxiliary pumps

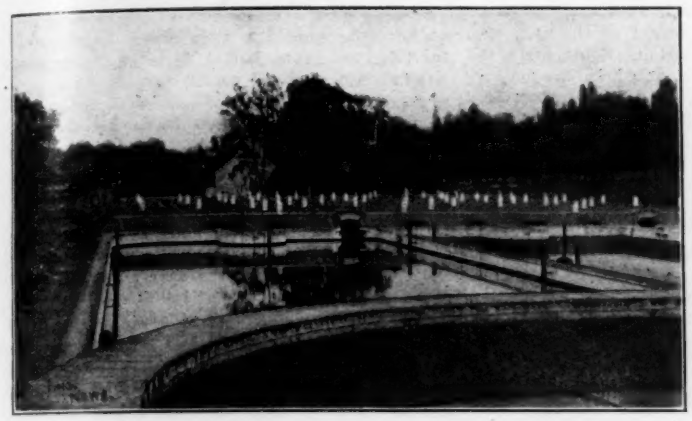

FIG. 7. FILTERS AND CLEAR WATER BASIN.

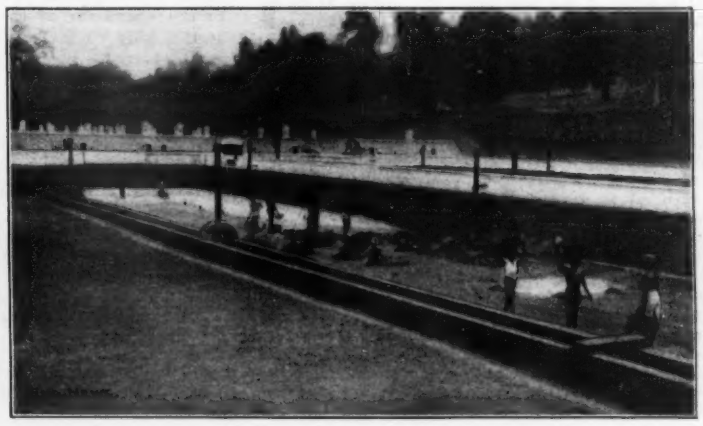

FIG. 8. SCRAPING A FILTER.

FIGS. 7 AND 8. WATER-WORKS FILTERS, SINGAPORE, STRAITS SETTLEMENTS.

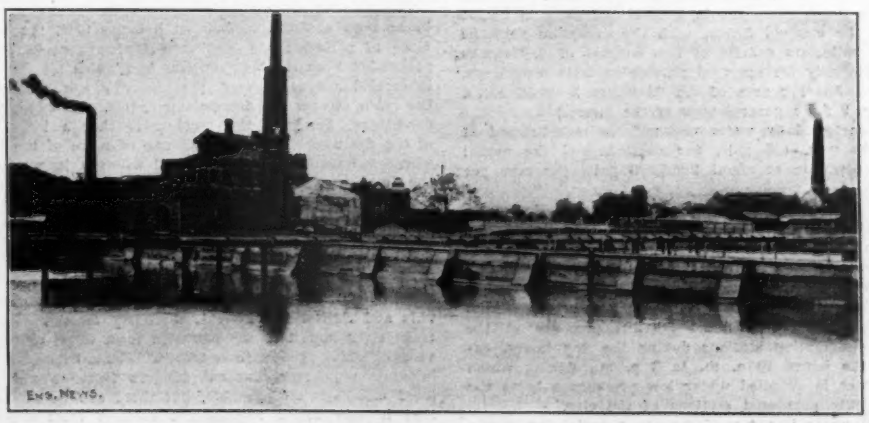

FIG. 6. SETTLING RESERVOIRS AND FILTERS, SHANGHAI, CHINA.

*A number of the details which follow have been taken from an article by the designer of these works, Mr. E. B. Weston, published in the Engineering Record, Dec. 17, 1904.

here force the water through mains direct to the consumers in the northern part of the city, the remainder being discharged into three reservoirs, two situated in the town and one in the suburbs, from each of which it is again pumped to the remainder of the consumers.

The original settling basins, construction of which was begun in 1867, are six in number, and are built of masonry. Four are provided with semi-concentric silt-catching pits, and two are plain. The original basins are each 500 × 250 ft., and range in depth from 7 to 9 ft. The total capacity of these six basins is 21,000,000 gals. The "new" settling basins, finished about 15 years ago, are merely earth excavations, puddling being practically dispensed with. Notwithstanding the fact that these basins are excavated in a sandy clay, the leakage amounts to practically nothing. Two of these basins are each 2,500 × 350 ft., × 9 ft. deep. The remaining two basins are each 2,500 × 250 ft., × 9 ft. deep. The total capacity of the four basins is therefore 84,000,000 gals., making a total settling capacity of 105,000,000 gals. These basins are worked on the fill-and-draw plan, and the period of sedimentation is therefore variable.

As the water enters the settling basins it is treated for approximately three months in the year, namely, during the rainy season of July, August and September, with aluminoferric. The chemical is applied in the proportion of about 2 grs. per gal., although the method of application precludes accurate measurement. A bag of chemical is suspended directly over the inlet, and is dissolved by the inflowing water. The aluminoferric costs about $20.50 per ton delivered at the works.

The original filters are twelve in number, each 100 × 200 ft., corresponding to a total filtering area of 5.51 acres. The filtering material consists of 30 ins. of fine river sand, supported on 4 ins. of coarse sand and 12 ins. of graded gravel, respectively. The effluent collectors consist of small cross drains covered with tiles. These drains lead the effluent to main collectors laid along the center of the beds, and these main drains deliver the effluent into collecting wells, from which it flows directly

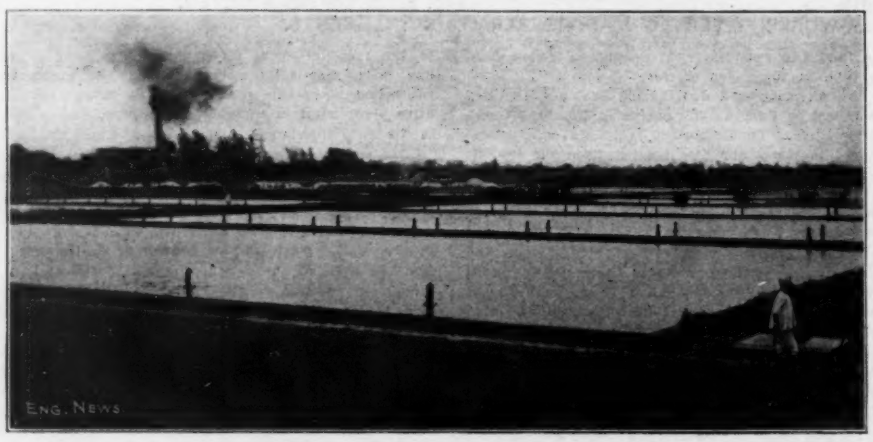

FIG. 9. WATER-WORKS FILTERS, CALCUTTA, INDIA.

into the conduits leading to the auxiliary pumping station on the outskirts of the city.

The new filters are 24 in number, each 200 × 100 ft., corresponding to a total area of 11.02 acres. In construction these filters are in general the same as in the case of the original filters, with the exception that the effluent collectors consist of two courses of dry bricks laid sufficiently far apart to provide suitable waterways. The total filtering area of the 36 filters is 16.53 acres. [See Fig. 9 for a general view of the filters.]

The average daily water consumption is estimated at 27,000,000 gals. (25 gals. per capita), and the actual rate of filtration at about 2,825,000 gals. per acre per 24 hrs.

There are three effluent-collecting wells in the plant, with a total capacity of about 42,000 gals., and from these wells the filtered water flows through two conduits to the outskirts of the city. These conduits are 4 and 3.5 ft. in diameter, respectively, and 12.5 miles long.

It is the custom at present to supply filtered water to the entire city under about 30 lbs. pressure at the various distributing stations during the day hours, excepting the hours 10 a. m. to 3 p. m., during which hours water is supplied under low pressure only to the more thickly populated sections of the city.

Filtered water is not used for street sprinkling, sewer flushing or fire-extinguishing purposes, a complete separate unfiltered water system being in use for this purpose, the water being pumped direct from the river into the raw water mains.

A TRANSPORT FOR SUBMARINE VESSELS, for the Japanese government, will convey the submarines to the place of action, where they will be floated from within, thus ensuring secrecy of action.

WATER POLLUTION IN THE OSWEGO AND UPPER HUDSON RIVER DRAINAGE AREAS.

Since its reorganization the New York State Department of Health, through its Division of Sanitary Engineering, has been making extensive studies of the pollution of some of the most important streams in the State. In the monthly bulletins of the Department for May and July, 1907, abstracts of lengthy reports on the Oswego and the Upper Hudson River drainage areas, respectively, were printed. Judging from these abstracts, the investigations thus far made have been more comprehensive than any of the kind heretofore entered upon, and they seem to give promise of more practical results than usually follow such efforts. This promise is due in part to the character of the work done, and in part and largely to increased powers of the Department given by recent legislation. Some extracts from these reports, as abstracted in the bulletins, are given below. Mr. Theodore Horton, M. Am. Soc. C. E., is Consulting Engineer of the State Department of Health, and Prof. H. N. Ogden, Assoc. M. Am. Soc. C. E., of Cornell University, Ithaca, N. Y., is one of the assistant engineers.

OSWEGO RIVER.

The Oswego River has a drainage area of 5,013 sq. mi., reaching from Rome nearly to Rochester and from Lake Ontario nearly to the Pennsylvania State line. It includes the "Finger Lake" section of the State, and has a diversified topography ranging from Elev. 246, the level of Lake Ontario, to a maximum of some 2,000 ft. Near Lake Ontario the country is flat. Some of the lake and river valleys have steep slopes. On the subject of slopes and their effects, the bulletin mentioned may be quoted as follows:

> The velocity of the main streams in the side valleys being high and the surface wash being foul, the conditions of pollution are ideal and the dangers to be apprehended from the main stream into which all the wash is carried are very great, provided any use is made of the main stream for domestic purposes. To offset these conditions, however, the fact exists that a large part of the drainage comes through one or more of the lakes where sedimentation is active and where a large part of the impurities are deposited. This mitigating circumstance is true not only of the surface wash but also of the sewage of the large cities. Thus Syracuse discharges into Onondaga Lake; Auburn, into a series of ponds used for power purposes; Ithaca, into Cayuga Lake; Geneva, into Seneca Lake; Rome, into Oneida Lake; Canandaigua, Seneca Falls, Waterloo, Lyons, Newark, Clyde, Baldwinsville and Fulton and Phoenix discharge directly into the main river and it is the pollution from those cities and villages which is most to be feared. The efficiency of sedimentation in removing *all* dangers from sewage polluted waters is questionable, but there can be no doubt that it very much reduces the dangers from drinking such contaminated water.

As a whole, the drainage area is agricultural. The lake water surface totals 295 sq. mi., or about 6% of the whole drainage area, and tributary to these lakes are 3,564 sq. mi., or 71% of the total drainage area. To quote again from the report:

> This emphasizes the importance of the sedimentation process carried on in the lakes and the relatively small area over which immediate and careful supervision is necessary, namely, that area and those cities and villages which do not drain into the lakes, but directly pollute the main river.

The total population of the drainage area is about 490,000, giving an average density of 98 per sq. mi., or, omitting Syracuse, 78 per sq. mi. There are eight cities in the drainage area, ranging from Syracuse, with a population of 117,498, to Oneida, with 8,420 inhabitants. These eight cities, together with a number of villages having sewerage systems, embrace a total population of 284,720. The population of the eight cities (230,532) comprises nearly half of the entire population in the drainage area. The sewage of these eight cities is discharged directly into the main stream or its tributaries.

The monthly average flow of the Oswego River at Minetto, some five miles above Lake Ontario, for the four years 1901-4, inclusive, varied from a minimum of 2,813 cu. ft. per sec. to a maximum of 18,721; but in 1899 and 1900 the summer flow was less than 1,000 cu. ft. per sec. during all the summer months, reaching a minimum of 585 cu. ft.. per sec. in October, 1899, or .11-cu. ft. per sec. per sq. mi. of drainage area. It should be noted that a large part of the natural drainage is diverted by the Erie Canal. In the Barge Canal report, the general statement is made that the low-water flow of the Oswego is .23-cu. ft. per sq. mi., or a total of 1,150 ft.

The chief pollution of the river and its tributaries is from sewers, but no sewer gagings are available. Basing the probable sewage flow on the per capita water consumption of 100 gals. per day for the eight cities now provided with sewerage systems, would give a sewage flow of 30 cu. ft. per sec. Making allowances which need not be gone into here, the flow of sewage may be assumed as ranging from 52 to 46 cu. ft. per sec., which, with a total stream flow of from 550 to 1,150 cu. ft. per sec., would give a dilution of from 12 to 23 times, as compared with 25 to 40 times, generally considered necessary to avoid offense. Figuring another way, with an allowance of 4 cu. ft. per sec. stream flow to dilute the sewage of 1,000 persons, a stream flow of 948 cu. ft. per sec., or nearly twice the "actual occasional minimum," would be required to prevent nuisance. From this it will be seen "that the river is barely able to assimilate the pollution and that local pollution will undoubtedly result and that a generally unsatisfactory condition of the river in its lower reaches must inevitably result in the near future."

The abstract next takes up the various lakes and tributary streams in some detail. The city of Syracuse and five villages on Onondaga Lake give an estimated sewage flow of 18 cu. ft. per sec. This is diluted, by the flow from the outlet of the lake, only 2 to 4 times. The abstract states that the minimum flow from this lake is probably in excess of what would be expected from the drainage area, "due to the absence of springs at the bottom of the lake," and that "the otherwise inevitable nuisance is probably avoided" by the large quantities of calcium chloride dissolved in the lake by the Solvay Co.

Passing over Skaneateles and Owasco lakes, it may be noted that the chief pollution of Cayuga Lake comes from the city of Ithaca, and that the danger from this pollution is minimized by the sedimentation afforded by the length of the lake; and, in addition, a sewage purification plant is now under construction by the city.

Passing again the comments on some of the other lakes, a summary of lake and stream pollution may be quoted as follows:

> In the Canandaigua Outlet, where the dilution is apparently from 20 to 40 times, the artificial ponding in the lake at low water seasons has caused a local nuisance.
>
> In the Owasco Outlet, where the dilution is apparently from 4 to 9 times, a serious nuisance is almost constantly maintained. At Port Byron, where the village takes its water supply, the conditions are revolting in the extreme.
>
> In the lower end of the Seneca Outlet there is local pollution, which, while not yet serious, requires attention to prevent future difficulty.
>
> The outlet from Onondaga Lake, as well as the waters

of the lake itself, is seriously polluted by the drainage from Syracuse.

Just above Oswego, where the dilution is from 12 to 23 times and the conditions particularly menacing on account of the Oswego water supply, which comes from the river and is delivered to the city without purification, the matter of the pollution is so serious as to deserve immediate attention. Fortunately, Oswego is the only city on the watershed where the health of the residents is in immediate and constant danger from the condition of their water supply. Port Byron has a grossly polluted supply, but it is so well understood that no one uses it. The other places taking water for drinking purposes from the surface supplies on the watershed are Syracuse, Auburn, Geneva, Penn Yan and Canandaigua, all depending on sedimentation in the large lakes to keep the water pure. Syracuse, Auburn and Penn Yan have water rules which probably will keep their supplies good, although villages in the south ends of Owasco and Seneca lakes discharge sewage directly into the lake. Oswego has suffered from the effect of sewage in its drinking water. A reasonable typhoid fever death rate per 100,000 is, for surface supplies, from 15 to 20, a death rate which Oswego had, except for the year 1893, until Fulton built its sewers in 1896. Since that time the typhoid fever death rate has gradually but certainly increased, fluctuating with the amount of typhoid fever in Fulton probably as well as with (in reverse order) the flow, of the river. In 1901 and 1902, for example, when the rainfall and stream flow were low, the ample sedimentation behind the dams settled out most of the dangerous germs. The years since then have seen rapid increase in deaths from that cause in Oswego.

It is possible that in the course of years Oswego will secure a new supply from the waters of Lake Ontario, but this will apparently not be possible for some years and it will cost the city of Oswego many lives before that time if the present conditions continue.

At the conclusion of the abstract of the Oswego River report, under the head "The Policy of the Department," there is printed a statement which has been mailed to the authorities of the various cities and villages in the Oswego drainage area. This we reprint as follows:

To the end that these dangers from pollution may be eliminated and that the waters of the Oswego River may, as far as is practicable, be returned to their original purity, this Department has notified the public officials of the municipalities in the Oswego River watershed that it will hereafter require that no sewage shall be discharged into any of the waters of the Oswego River without preliminary treatment. This requirement of preliminary treatment is in accordance with section 75 of the Public Health Law. The degree of purification required by this Department will depend upon local and other conditions affecting the public health and comfort of the residents who dwell in the vicinity of these streams, or receive their water supplies from them, but will, in general, be as follows:

(1) In the case of persons, corporations or municipalities situated on lakes of the Oswego watershed, not used for public water supplies, no sewage shall be allowed to enter such lakes without being first purified to such a degree that all solid and suspended matter will be removed, and that no odors or other offense shall be created in the vicinity of the points of sewage discharge.

(2) In the case of persons, corporations or municipalities situated upon the Oswego River and the main branches which form outlets to the lakes of the Oswego watershed, and upon all lakes used as a source of public water supply, no sewage shall be allowed to enter such waters without being first treated by a complete process of purification, the effluent from which shall at all times be free from all suspended matter and any dissolved or other organic matter that may undergo subsequent putrefaction.

The above outline of the general policy of the Department is offered as a guide to local authorities of municipalities, owners of manufacturing or industrial establishments, and private individuals, having at present or in contemplation, public or private sewerage systems that may drain into any of the waters of the Oswego River, and to indicate to them, in a general way, the conditions upon which plans will be approved, and permits for the discharge of the sewage thereof issued. It is expected that local conditions may alter these requirements with respect to the manner of sewage discharge, and to the degree of purity of the effluent from the sewage disposal works. It is also expected that with the future growth of population upon the watershed and the resulting increase of sewage that will have to be cared for, the requirements for more complete methods of disposal and for greater purity of effluents may be demanded.

THE UPPER HUDSON.

The report on the Upper Hudson River was made pursuant to an order issued by Governor Hughes, which directed the State Department of Health to investigate the pollution due to sludge acids, to wastes from pulp mills and other industrial establishments, and to sewage. The investigation continued through the greater portion of June and July, and the resulting report covers some 275 typewritten pages. The topography, geology and hydrology of the Upper Hudson is set forth in the full report, but is not touched upon in the abstract. A summary of that part of the report dealing more particularly with industrial wastes is printed below, together with the general conclusions based on the whole investigation.

The Upper Hudson River and its tributaries are polluted by the industrial wastes from some 35 pulp and paper mills, 10 knitting mills, 8 woolen mills, 7 wall paper mills and 3 cotton print mills in the States of New York, Massachusetts and Vermont; and by the domestic sewage of a population of some 79,000 residing also in these three States.

The total pollution from industrial wastes amounts to about 1,460,000 lbs. daily, of which about 98.7% is derived from pulp and paper mills, 0.1% from knitting mills, 0.7% from woolen mills, 0.1% from wall paper mills and 0.4% from cotton print mils.

Of this total amount of wastes, about 79% is of organic origin and about 21% mineral. Of the organic matter, about 13.5% is pulp fiber from ground wood pulp and from the paper mills and about 61% is dissolved wood lignin from sulphite pulp mills; about 4% is woody refuse from the soda ash process and the remaining 0.5% is refuse from woolen mills, knitting mills and other industrial plants. Of the 21% mineral matter, about 17% is from chemicals used in pulp and paper mills and about 4% from knitting, woolen and other mills.

Of the total wastes approximately 96% are discharged into the Hudson River, about 1.5% into the Batten Kill, about 1.5% into Kayaderosseras and Fish creeks, and 1% into Hoosick River.

In considering the effects of pollution the report points out that industrial wastes affect almost exclusively public comfort and convenience, while domestic sewage affects almost exclusively public health and life and, owing to its relatively small amount, has little effect upon pubic comfort. The following conclusions are then drawn:

(1) Above Corinth there is no appreciable pollution of the Hudson River.

(2) The pollution of the river begins at Corinth where a pulp mill discharges sulphite waste.

(3) From Glens Falls to Fort Edward there are ten mills which add very much to the pollution.

(4) Owing to the large amount of wastes discharged into the Hudson River above Fort Edward the pollution of the river below Fort Edward by industrial wastes is more intense than at any other point along its course and the effect upon public comfort the most serious and the interference with the full enjoyment of property most complete.

(5) The pollution of the Hudson River below Fort Edward from industrial wastes consists almost entirely of the chemicals and pulp fiber discharged into the river by the pulp and paper mills, the effect of which upon the river is to discolor the water, increase the turbidity, fill the stream to a more or less degree with fine suspended and coarse masses of pulp fiber and to produce a deposit of pulp fiber and chemicals upon the banks and bed of the river. These conditions of the river continue in a considerably diminishing degree, for a distance of many miles below Fort Edward, and in an appreciable degree as far down as the Mohawk River.

(6) The effect of this industrial pollution upon the comfort and convenience of residents at Fort Edward and below on the river, is to render the water unfit for drinking or other domestic purposes; to detract from the pleasures of boating and bathing, and to poison and kill the fish.

(7) There is no indication that the crops raised upon any lands flooded at times by the river are injured in any way by the pollution of the stream.

(8) During this investigation no odors were detected arising from the water of the river except at the points immediately below sulphite pulp mills, although odors from the sulphite mills themselves were detected for a distance of two miles or more in the direct path of the wind.

(9) There is no reliable evidence that the wastes from these industries upon the Upper Hudson affect in any appreciable degree the security of life and health of persons residing in the municipalities or along the river.

(10) The conditions found to exist in the Hudson River constitute a public nuisance, causing injury, inconvenience, annoyance and discomfort to riparian owners in the enjoyment of their legitimate and reasonable rights of property; the present discharge of the industrial wastes described is unauthorized and unwarranted, offensive to the senses, and its continuance is unreasonable; and it injures and damages riparian owners to a material degree in their legitimate right to the enjoyment of comfort and property.

SOME RECENT STREET RAILWAY TRACK CONSTRUCTION.

With the increase of traffic and the introduction of larger and heavier cars, a more substantial system of street railway track construction is being required in many cities, and this is especially the case where the cars of interurban lines are operated on the streets. Some recent methods of construction are noted below, and in regard to the Chicago lines it may be explained that their long neglect during the protracted periods of litigation and controversy over franchises and financial affairs has necessitated very expensive reconstruction. The old tracks are not only inadequate for the service imposed upon them, but have been allowed to deteriorate until they are practically beyond repair.

CHICAGO.—The reconstruction of the track system of the different street railway lines is being pushed forward rapidly, under the general supervision of the Board of Supervising Engineers. Designs for three types of track have been prepared by the Board, to meet different requirements, and pending their official adoption they were tentatively approved in order that the companies might proceed with the work during the present season. Any changes in the plans finally adopted will probably be in matters of detail. The two designs for heavy track construction provide for a concrete base in which steel or wooden ties are embedded, spaced about 5 ft. apart. The third design provides for a bed of stone ballast upon which are laid wooden ties, with concrete filled in between and over the ties. In all cases the rails are of the 9-in. 129-lb. grooved girder type, illustrated in our issue of May 23, 1907. We defer publication of the plans until they have been officially adopted, but it will be of interest to note some of the methods of the reconstruction work now in progress on the Chicago City Ry., of which Mr. Harvey B. Fleming is Chief Engineer. The Board of Supervising Engineers is composed of Mr. B. J. Arnold, M. Am. Soc. C. E. (Chairman), Consulting Engineer for the City; Mr. Charles V. Weston, M. Am. Soc. C. E., representing the city; Mr. H. B. Fleming, representing the Chicago City Ry., and Mr. J. Z. Murphy, representing the Chicago Union Traction Co.

In the reconstruction of the old cable line on Cottage Grove Ave., one track is abandoned for a distance of two or three blocks and a temporary track laid with T rails on widely spaced ties; these are placed on the surface of the street, the surface being, if necessary, leveled up with cinders, gravel or broken stone. This arrangement is made practicable by the great width of the roadway, but is followed also in the narrower portions, one side of the street being temporarily closed. The old girder rails, which had cast-welded joints to form continuous rails, are then sawed apart by hack saws into convenient lengths and removed from the supports on the yokes embedded in the concrete. The upper parts of the yokes are then broken off and the concrete of the old cable conduit broken up by hand drills and sledges to a sufficient depth to accommodate the new construction. Conduits of vitrified clay for the electric cables are laid in the bottom of the old cable conduit, which is then filled with the concrete. A track is then laid with the new rails on steel ties, and is held in line and surface by blocking while the concrete is being deposited around it. On some parts of the work concrete mixing machines travel along the track, while at other parts the concrete is made by hand on mixing platforms. In this concrete are embedded steel ties of the Carnegie or I-beam section, but these are inverted from the usual position, having the wider flange uppermost. On the old cable lines they are spaced to alternate with the cable yokes; on other lines they are 5 ft. c. to c. At each rail seat is a steel tie-plate, and the rail and tie-plate are secured to the tie by steel wedges, two of which are driven into each hole in the tie, the hooked head of one of the wedges engaging with the rail base.

The rails of the section above mentioned are delivered in 60-ft. lengths; they are connected at intervals by transverse tie bars, having the ends

forged round and threaded to pass through the webs of the rails, where they are secured by nuts on each side of the web. The rails are laid with square joints, spliced with very short bars of channel section having a narrow outside rib at top and bottom, and on the inside a rib at the middle which bears against the web of the rail. Only two bolts are used at each joint (one in each rail), and these are placed close to the bottom of the rail. The concrete is filled in above the level of the rail base, but the surface is depressed at the joints so as to leave the bolts uncovered. When the concrete has set, sand is filled in upon it and granite paving blocks are laid flushed with the top of the rail. The paving is grouted with hot pitch and fine gravel is then swept over the surface to fill all the interstices. When this section of track is completed, traffic is turned upon it and the parallel track then treated in the same way.

On the less important streets, and where the cable conduits do not exist, a lighter form of construction is used. In the reconstruction of the Forty-third St. line with this lighter system of track, one track was abandoned for a considerable distance, and one side of the street closed to traffic, the width not permitting of a temporary third track as in the work above described. The old track was then torn up and an excavation made to the required depth for the new roadbed. The surface was then rolled with a light Iroquois steam roller of the vertical boiler type, and broken stone then filled in to a depth of 8 ins. This was in turn rolled with the same machine. Upon this are laid wooden ties 24 ins. c. to c. (shoulder ties 12 ins. from the joint). The same girder rails as above described are used, and are fastened to the ties by screw spikes. An interesting feature of this work is the use of electric drills to bore the holes for the spikes and to screw the spikes into the holes. Power for this service is obtained from the trolley wire by means of poles having conductors which hook upon the wire. The speed of operation as compared with hand augers and hand wrenches is very considerable. Upon the track thus completed is run a concrete mixing machine, the stone and gravel for which are deposited at the side of the track by the company's construction cars. The machine delivers the concrete directly between the rails, where it is tamped and leveled to the required surface. The concreting being completed, sand is deposited and stone paving laid as already described.

One of the special features of the Chicago work is the use of traveling concrete-mixing machines for the great amount of concrete required in the track foundation. Some of these machines are of the Drake type, having a mixing trough in which runs a shaft fitted with paddles or blades. One of four special machines built for the Chicago City Ry. work by the Drake Standard Machine Works, of Chicago, is shown in Fig. 1. A long steel frame or underframe is mounted on trucks and carries at its rear end the concrete mixer, from the end of which the concrete is delivered directly into the track. The mixer is beneath the frames and directly under the cab, the truck having small wheels in order to give the necessary space over the axles. Along the remainder of the frame is a trough in which runs a conveyor chain. The material previously deposited along the side of the street has the stone and sand ready mixed, and the cement is laid upon this continuous bed of material as the machine advances. The material thus prepared is shoveled into the conveyor trough of the concreting machine by a gang of men in the street, thus avoiding all handling by wheelbarrows. On the Forty-third St. line above mentioned, a somewhat different equipment was used. A steel frame flat car had at the rear end a drum mixer, built by the Chicago Concrete Mixer Co., while at the forward end was a jib crane and a frame carrying the trolley pole. Stone and sand deposited along the street (between the track and the sidewalk) was carried in wheelbarrows to the mixer and delivered from the barrows to the mixer by a steel bucket handled by the crane. The concrete is composed of 1 part Portland cement to 3 parts sand and 6 parts 1½-in. broken stone. This is mixed moderately wet and tamped in place.

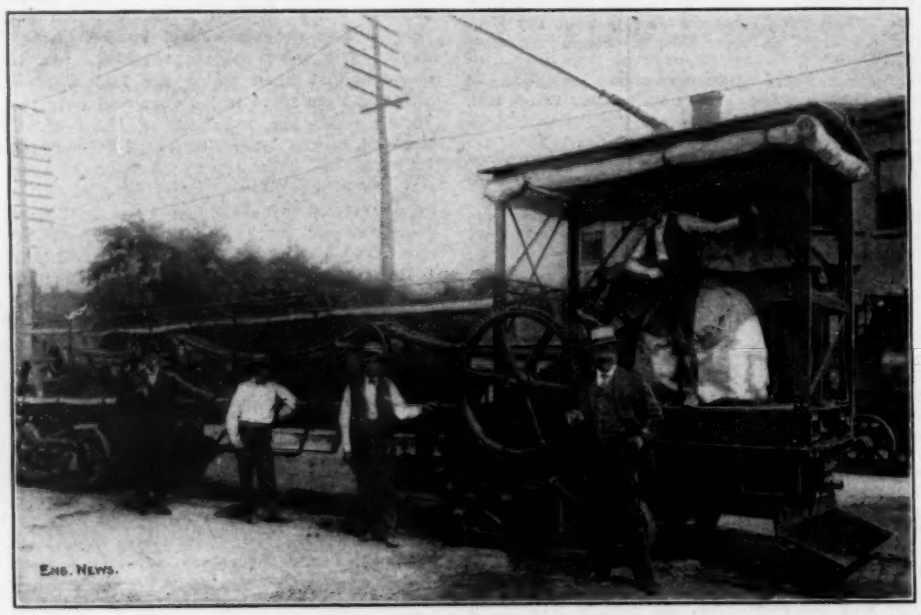

FIG. 1. CONCRETE MIXING MACHINE FOR TRACK RECONSTRUCTION ON THE CHICAGO CITY RY.
Drake Standard Machine Works, Chicago, Builders.

INDIANAPOLIS, IND.—The new standard track construction of the Indianapolis Traction & Terminal Co. is on the combination tie and beam system, the 10-in. concrete beam or stringer (10 ins. deep beneath the rail) being part of the 6-in. concrete foundation of the street paving. This beam has generally been made with an 18-in. flat bottom and sloping sides, but in the latest construction it is of curved form, as shown in Fig. 2. The concrete is composed of 1 bbl. Portland cement to 12½ cu. ft. of sand and 25 cu. ft. of washed gravel. The wooden ties are 6 × 8 ins. 8 ft. long, spaced 10 or 12 ft. c. to c., the concrete being 6 ins. deeper for a width of 24 ins. under each tie. For each rail there is a brace tie-plate on the tie, and two of these plates at intermediate points, these latter having two anchor bolts embedded in the concrete. The rails are of a 7-in. 91-lb. special T-girder section, designed jointly by this company and the Cincinnati Traction Co. which paid for the making of the rolls. The feature of the section is the unusual thickness of the web, which is 9-16-in.; this was considered necessary for sufficient stiffness in view of the fact that the tracks have to carry interurban cars weighing as much as 50 tons. All tracks are paved with brick, a nose brick for the grooves being laid against a wooden filler fitted to the web of the rail. The bricks are laid on dry grout between and outside the rails and track, and on sand between the tracks. The use of the rail anchor above noted is to resist the tendency of brick paving to arch, or rise off the sand cushion, when expanding due to hot weather.

Where the cross-tie system of construction is used, the white oak ties are spaced 2 ft. apart, with a brace tie-plate on every third tie. The ties are laid on 6 ins. of gravel concrete, and concrete is filled between and over them. The use of ordinary concrete under the ties necessitates the stopping of traffic, as the track cannot be held to line on wet concrete, and where it is not practicable to divert traffic a dry concrete is used. The gravel and sand are excavated from the company's pit with a ½-yd. Hayward orange-peel bucket, two sacks of cement are thrown upon it, and the load is then dropped into a Drake trough mixer, which delivers it directly to the ballast cars. This concrete has the ordinary moisture of the pit gravel. It is laid in the same way as gravel ballast, and the track properly lined and tamped to the permanent grade. Mr. Thomas B. McMath, Chief Engineer, states that this practice, which originated with him, has been very successful. Excavations made in the dry-concrete ballast after several months show that the absorption of moisture from the concrete to set to a strength approximately 80% of that of similar concrete mixed with water in the usual way. At the end of three years, it seems to be practically as strong as ordinary concrete, and the track has maintained its line and grade. At Mr. McMath's recommendation the system has been employed also in Columbus and Frankfort.

The quantities of material per mile of single track for these two systems of construction are given in the accompanying table:

TABLE OF QUANTITIES OF MATERIAL IN TRACK CONSTRUCTION AT INDIANAPOLIS.

	Cross-Tie Type.	Tie and Beam Type.
Rails, 91-lb., tons	143	143
Ties	2,640	528
Joint plates, pairs	176	176
Paving, sq. yds.	4,400	4,400
Concrete, cu. yds.	1,336	1,036
Spikes	10,560	2,112
Track bolts, 1 × 4¼ ins.	704	704
Joint bonds	352	352
Cross bonds	10	10
Brace tie-plates	1,760	3,168
Anchor bolts, ¾ × 10 ins.	3,520	6,336
Washers, ¾-in. cast-iron	7,040	12,672

In the latest construction, laid on West Michigan St., during the present year, the groove is formed by double blocks instead of the usual nose block. A rectangular block lies against the web of the rail and extends far enough beyond the head to form the bottom of the groove. Against this is a line of stretchers having the corner beveled. Between the groove blocks and between the tracks, the regular bricks are laid transversely to the track. Outside of the rails they are laid parallel with the rails.

KANSAS CITY, MO.—The Metropolitan Street Ry. Co. has abandoned the concrete stringer system formerly used, in favor of the cross-tie system shown in Fig. 3. The ties are laid on 6 ins. of stone ballast, which is also filled between them for 2 ins. Above this is the concrete filling to form the foundation of the paving. With asphalt paving a course of brick is laid on each side of the rail. In the business section of the city a 141-lb. grooved girder rail is used, but on other streets 100-lb. T rails of the Am. Soc. C. E. section are used, as shown. As a rule, however, deeper rails of the T-girder section (as used at Indianapolis and shown in Fig. 2) are preferred for street railway work in paved streets.

TORONTO, CANADA.—In the present standard construction of the Toronto Ry. Co. the entire street is given a concrete foundation 6 ins. thick, which is increased to 12 ins. under each rail for a width of about 20 ins. The concrete

under the track is laid in two layers: the first layer reaches to within 4¼ ins. of the base of the rail, and has a few wooden blocks set in it, to which the track structure is temporarily fastened and skimmed to surface. The track structure is then put in place, and concrete tamped and grouted in to the level of 1¾ ins. above the base of the rail. On top of this a 1-in. sand cushion is laid and a 4¼-in. paving block brings the pavement to the level of the surface of the rail. For the track, a 7-in. grooved girder rail or a T rail is used, according to location. With the latter a specially shaped scoria block is used on the inside of each rail to form the groove. The rails are connected at intervals of 6 ft. by ⅞-in. round tie-bars, while at 12-ft. intervals they are bolted

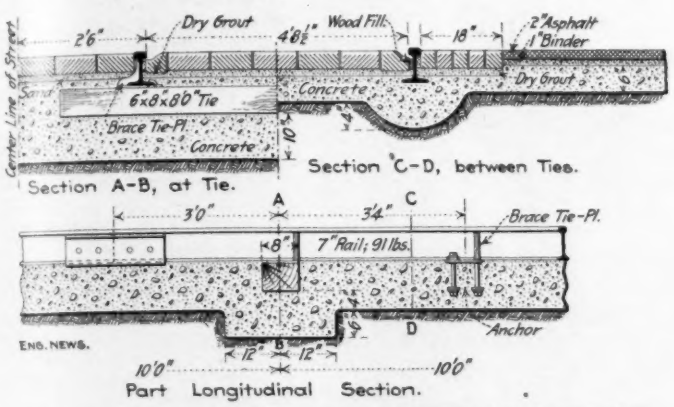

FIG. 2. STREET RAILWAY TRACK CONSTRUCTION FOR THE INDIANAPOLIS TRACTION & TERMINAL CO.

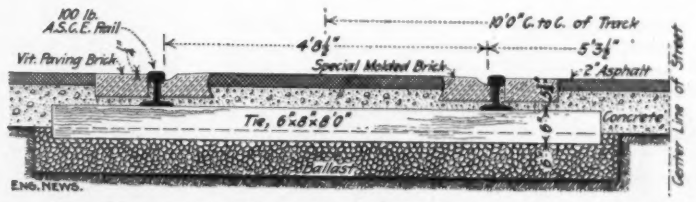

FIG. 3. STREET RAILWAY TRACK CONSTRUCTION FOR THE METROPOLITAN STREET RY. CO., KANSAS CITY, MO.

to steel ties made of inverted pieces of old 4¼-in. T-rails. The joints are of the Atlas and Continuous patterns, with 24-in. splice bars. Rails 60 ft. long are preferred. As the paving in the track allowance is done by the city, the details of construction vary slightly in different places.

THE LACING OF COMPRESSION MEMBERS.

By C. T. MORRIS,* Assoc. M. Am. Soc. C. E.

The maximum unit-stress on the compression or concave side of a "long column," loaded to its safe limit, is greater than the average unit-stress as given by the column-formula, and at the ultimate load it is equal to the ultimate strength of the material in compression. Therefore, it is logical to assume that at the maximum *safe* load the maximum unit-stress is equal to the maximum allowed compression on short pieces.

In a column composed of two leaves laced together, assuming that the load at the ends is applied equally to the two leaves (if it is not we have eccentric loading), one-half of the total maximum difference in stress, between the two leaves, must be transferred by the lacing from one leaf to the other.

Let s_1 = maximum allowed unit-stress in compression on short pieces.
s_c = average allowed unit-stress on column, from a column formula.
A = total area of column cross-section.
$\frac{A}{2}$ = area of each leaf.
l = total length of column.
V = half the total difference in stress between the two leaves = amount of stress transferred by the lacing.

Then $$V = (s_1 - s_c)\frac{A}{2}$$

In a pin-ended column, which deflects into a simple curve, this stress V must be transferred in the distance ½ l, or from the end to the middle, but in a square-ended column the stress V must be transferred in the distance ¼ l because the stress in the two leaves must be equal at the points of contraflexure which are at the quarterpoints, as at these points the bending moment is zero.

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v = the increment of stress per unit length of column

$$v = \frac{2(s_1 - s_c)A}{l} \text{ for square ended column} \quad \ldots\ldots(1)$$

The increment for a pin-ended column in which the pin is perpendicular to the plane of the lacing, is evidently one-half that given by Eq. (1). This case is not so frequently met with as the other.

Eq. (1) may be applied no matter what column formula is used, so long as the column has only two leaves. A similar formula may be worked out for multiple-leaved columns by proportioning the difference in the stresses in the leaves to their distances from the neutral axis.

If a straight-line column-formula is used, of the form

$$s_c = s_1 - c\frac{l}{r} \quad \ldots\ldots(2)$$

(1) becomes

$$v = \frac{2cA}{r} \quad \ldots\ldots(3)$$

EXAMPLE.—Given a column composed of two 15-in. 33-lb. channels laced together, toes out, 9½ ins. back to back.

A = 19.8 sq. ins.
r = 5.62 ins.

$$s_c = 16{,}000 - 70\frac{l}{r} \text{ (Am. Ry. Eng. \& M. of W. Assoc. spec.).}$$

$$v = \frac{2 \times 70 \times 19.8}{5.62} = 494 \text{ lbs. per lin. in.}$$

If the lacing is single at 60°, the length of column covered by one bar will be 13.5 × cot 60° = 7.8 ins., and the vertical increment of stress transferred by one bar will be $\frac{7.8 \times 494}{2} = 1{,}925$ lbs. (lacing is on two sides of column).

The stress in the lattice bar will be 1,925 × sec. 60° = 3,850 lbs. The bar must be capable of transmitting this stress either in compression or tension; compression, of course, requires the more material.

Using the same column formula for the flat lace bar as for the column itself we get:

$$\text{Assumed thickness} = \frac{3}{8} \text{ in.} \quad l = 15.6 \text{ ins.}$$

$$r = \frac{t}{\sqrt{12}} = 0.108 \text{ in.}$$

$$s_c = 16000 - 70\frac{15.6}{0.108} = 5890 \text{ lbs. per sq. in.}$$

$$\text{Required area} = \frac{3{,}850}{5{,}890} = 0.65 \text{ sq. in.}$$

$$\text{Required width} = \frac{0.65}{0.375} = 1.75 \text{ ins.}$$

which agrees very well with ordinary practice.

By this same theory the required spacing of rivets in the flanges of a column may be found, just as is done in the flanges of a plate girder.

ADAPTATION OF THEORY TO A COLUMN WITH FOUR RIBS.—Let

s_1 = maximun unit-stress in outer rib on concave side.
s_2 = maximum unit-stress in interior rib on concave side.
A_1 = area of outer rib.
A_2 = area of interior rib.
d_1 = distance between centers of gravity of outer ribs.
d_2 = distance between centers of gravity of interior ribs.

Then A = total area of column = 2 (A_1 + A_2).

From the theory of flexure

$$\frac{s_1 - s_c}{s_2 - s_c} = \frac{d_1}{d_2} \text{ from which } s_2 = s_1\frac{d_2}{d_1} + s_c\left(1 - \frac{d_2}{d_1}\right)$$

V_1 = stress transferred to A_1 by the lattice.
V_2 = stress transferred to A_2 by the lattice.

$$V_1 = A_1(s_1 - s_c) \quad V_2 = A_2(s_2 - s_c) = A_2(s_1 - s_c)\frac{d_2}{d_1}$$

Using the straight-line column formula Eq. (2),

$$V_1 = A_1 c\frac{l}{r} \text{ and } V_2 = A_2 c\frac{l}{r}\cdot\frac{d_2}{d_1}$$

$$v_1 = \frac{V_1}{¼\,l} = \frac{4A_1c}{r} \text{ and } v_2 = \frac{V_2}{¼\,l} = \frac{4A_2c}{r}\cdot\frac{d_2}{d_1}$$

The maximum longitudinal increment of stress taken by the lattice-bars is $v_1 + v_2$ and occurs between the inner ribs A_2, where

$$v_1 + v_2 = \frac{4c}{r}\left(A_1 + A_2\frac{d_2}{d_1}\right)$$

QUEBEC BRIDGE CHORD A9.—Here

d_1 = 56 ins. (about).
d_2 = 14 ins. (about).
A_1 = 195 sq. ins. (about).
A_2 = 195 sq. ins. (about).
r = 20.4 ins. (about).
$c = 50(1 + \theta) = 50 \times 1.75 = 87.5$.

$$v_1 + v_2 = \frac{4 \times 87.5}{20.4}\left(195 + 195 \times \frac{14}{56}\right) = 4170 \text{ lbs. per lin. in.}$$

This stress increment is distributed among four lattice-bars, two on each side of the column, and these bars cover a length of column of about 56 ins; therefore the shear carried by each bar is $\frac{4{,}170 \times 56}{4} = 58{,}400$ lbs. The stress in the bar would be 58,400 × sec. 45° = 82,500 lbs. The lattice-bars were single angles 4 × 3 × ⅜-in., which would therefore receive a unit stress of $\frac{82{,}500}{2.49} = 33{,}100$ lbs. per sq. in. when the column was stressed only to the safe limit given by the column formula.

THE SEWAGE WORKS OF SHEFFIELD, ENGLAND, treated a total volume of 7,003,500,000 U. S. gals. during the year ending March 25, 1907. Of this 6,604,188,000 gals. were treated by lime precipitation, and 399,312,000 by contact beds and other so-called bacteriological processes. The average total daily volume treated for the year was 19,176,000 gals. At present, new works are in progress, as follows: 6 settling tanks, of 1,200,000 U. S. gals. capacity; and 24 contact beds, each to have an area of ½-acre. These additional works are expected to treat about 14,400,000 U. S. gals. of sewage per day. Mr. Charles F. Wike, M. Inst. C. E., is City Surveyor of Sheffield.

A TEN-STORY REINFORCED CONCRETE BUILDING.

A reinforced concrete warehouse has recently been completed in Pittsburg which, on account of its size and of some details of construction and exterior finish, possesses a more than ordinary interest. The building, which is to be occupied by the Bernard Gloekler Co., in connection with the manufacture of refrigerators, store fixtures, machinery and supplies, has ten stories and a basement, and occupies an area of 82 × 100 ft. From the first floor level to the top of the cornice the height is 144 ft. 9 ins., and from first floor to top of basement floor the depth is 13 ft., the average story height being about 14 ft. 5 ins. The second, third, and fourth floors were designed for a live load of 300 lbs. per sq. ft., and the others for 250 lbs. per sq. ft., with a factor of safety of four throughout. It will be noted that these floor loads are from two to three times as great as the usual loads for high buildings of the ordinary steel frame type. The design was originally made for a steel skeleton construction, but was afterward changed to the present design at an estimated saving of $30,000. The general plan of the building remained the same.

Particular attention has been paid to the architectural treatment of the front of the building, both as to grace of the lines and fineness of the texture. While in the rest of the building the ordinary 1:2:4 gravel concrete mixture was used, the front face, for the first two stories, was built with a mixture of 1 part cement to 3 parts marble dust and above the second story a finely ground light-colored stone known as lignier was used instead of marble dust. The marbled face from the first floor line up to and including the belt course at the third floor is finished with a crandalled surface (Fig. 4); above this, the front, the remaining exterior walls, and the interior walls were treated with wire brushes and then finished with a cement wash applied with brushes, filling all voids and leaving a smooth surface. The Ionic columns and cornices in the upper stories were molded separately on the ground and set in place with the mass work molded around them.

Fig. 2 shows a vertical section through the building and Fig. 4 a typical floor plan. The columns and outer piers are founded on stepped concrete footings, resting on earth foundations. The general system of construction follows in the main the usual practice in reinforced concrete buildings, with the following details of make-up and reinforcement.

COLUMNS. — Circular concrete interior columns, varying from 22 ins. in diameter in the 1st story to 15 ins. in the 10th story, are used throughout the building, with the exception of the basement, where concrete columns 24 ins. square are used. There are four rows of these columns spaced 15 ft. 10 ins. in one direction and 24 ft. in the other direction. In order to avoid using larger size columns structural steel cores are used from the basement to the level of the 8th floor. These cores are made of star sections, both for simplicity of construction and to readily permit the tamping of the concrete about them. They are composed of four 6 × 6-in. angles, varying in thickness from ⅞-in. in the basement to ⅝-in at the 7th story, and one 13-in. and two 6-in. plates, varying from ¾-in to 5-16-in. in thickness. Angle brackets are riveted to the column cores just below the floor line at each story to receive the concrete beams and girders. Columns having structural steel reinforcement, contain in addition, four 1-in. rods placed 3 ins. from the surface. In the 8th story, the columns contain one 2-in. rod in the center and eight 1-in rods; the 9th story, eight 1-in. rods, and the 10th story columns, supporting the roof, four 1-in. rods. These rods are fastened together with ¼-in. wire ties spaced every 12 ins., except where steel cores occur, where they are spaced every 24 ins. Brackets 12 ins. deep, making an angle of about 60°, with the horizontal are used under beams and girders where these connect with the columns.

The wall columns vary considerably in size according to the loads carried, and are reinforced with round rods fastened together with ¼-in. wire ties every 12 ins. These rods are placed a distance of 3 ins. from the faces of the columns, the outside concrete being considered as fireproofing.

Where the steel column cores occur the column rods lap 3 ft., and are wired together. Where the cores are not used the ends of the rods are sawed square and butted together at splices, with pipe sleeves 10 ins. long to keep the rods in alinement. Iron base plates and pipe sockets are provided at the column footings to provide a bearing for the column rods.

GIRDERS.—All floor girders are 11 × 22 ins., with the exception of the 2d, 3d, and 4th floors, which are 11 × 26 ins. The roof girders are also 11 × 22 ins. All have a span of 24 ft., and are spaced 16 ft. c. to c. Each girder is framed into by three floor beams on each side. All the floor girders are reinforced with eight 1-in. twisted rods, and the roof girders with four 15-16-in. twisted rods. Where floor and roof beams frame into girders on opposite sides, a ¾-in. rod 4 ft. long, with 3-in. hooked ends is provided in the top of and at right angles to the girder and projecting into each beam to form a tie. Where the ends of the girders join at the columns, two ¾-in. rods, 6 ft. long are placed in the tops of and projecting into each girder forming a tie. There were also placed in the tops of and at right angles to the girders 5-16-in. rods 5 ft. long projecting an equal distance each side of the center of the girder into the adjacent slab to resist shear.

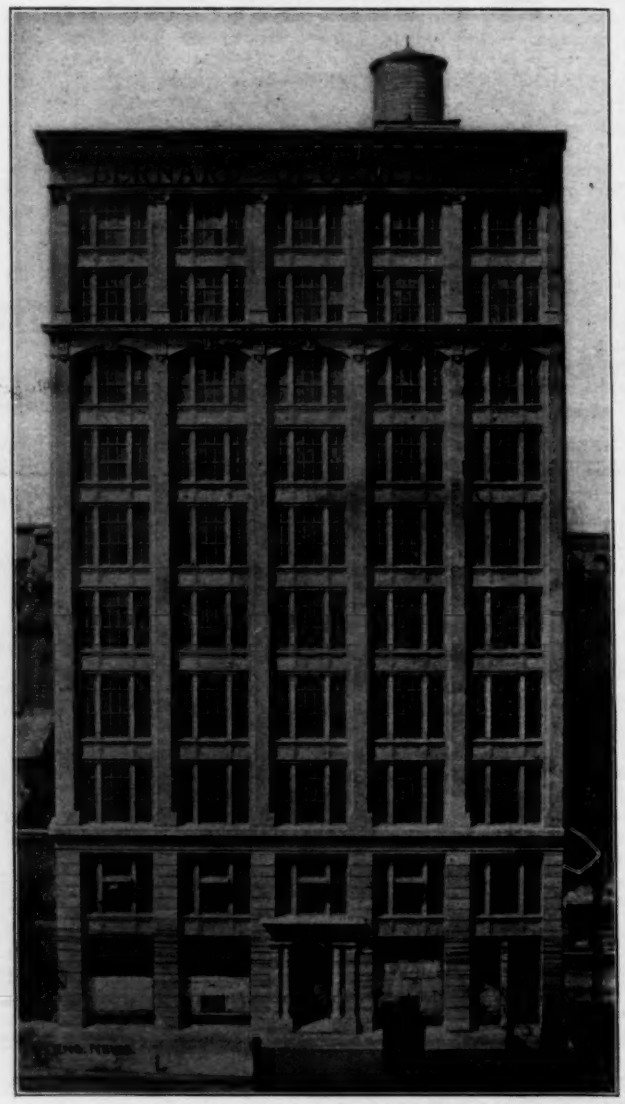


FIG. 1. TEN-STORY REINFORCED-CONCRETE BUILDING, PITTSBURG.

Ballinger and Perrot, Architects and Engineers.

Beams for all floors are 8 × 16 ins., and those for the roof are 6 × 16 ins. All have a span of 16 ft. and are spaced 6 ft. c. to c. Beams for the 2d, 3d, and 4th floors are reinforced with four ⅞-in. square twisted steel bars and for the remaining floors with four ¾-in. twisted bars; the roof with two ¾-in. bars.

All beam and girder reinforcement was bent and framed according to the system of the Unit Concrete Steel Frame Co. A typical reinforcement is shown in Fig. 6.

Straight rods were delivered adjacent to the building site and those intended for the beams and girders were then bent into the desired shape and securely fastened together. Attached to these frames are ⅛ × 1-in. U-shaped vertical stirrups which extend into the floor slab and have holes punched in their upper end through which the slab rods extend forming a bond with the slab. Typical beams have 14 stirrups and typical girders 18 stirrups. These frames were placed in the forms as one piece and by means of special sockets were rigidly fastened in the position intended by the design. These sockets were ordinarily spaced 4 ft. apart and left in the concrete to be used in the completed building for the attachment of shafting and other fixtures, sockets in addition to those used in the construction being put in where desired. Steel reinforcement for the beams and girders is placed two inches from the under side of same, the concrete below being considered as fireproofing.

The reinforcing rods for typical beams and girders are placed in two layers, half in each layer, the bottom layer running straight from one end of the beam to the other, and the upper layer running parallel with the lower in the center of the span for about 50% of its length span and bent up toward the top at the end of the beam.

FLOOR SLABS. — All floor slabs are 4½ ins. thick, and are reinforced with 5-16-in. twisted square bars spaced 6 ins. c. to c., with ¼-in. twisted square bars spaced 2 ft. c. to c., running at right angles. The roof slab is 3½ ins. thick, with ¼-in bars 6 ins. c. to c., and at right angles ¼-in. bars 2 ft. c. to. c. For both floor and roof slabs the reinforcement is placed 1 in. from the under side of the slabs. Small threaded cast-iron sockets were placed on the under side of the floor slabs for the support of electric wiring. Iron pipes are also placed in the beams and girders directly below the under side of the floor slab for the electric wires. The finished floor consists of 2 ins. of concrete placed directly upon the top of reinforced concrete floor slab with a 1-in. top coat of cement and sand laid off in blocks.

WALLS.—With the exception of the main entrance and the dentil course just above it, which are of artificial stone, the exterior is entirely monolithic. The side walls of the building are constructed to meet the requirements of party walls, and vary in thickness from 24 ins. in the basement to 14 ins. in the 8th story. The reinforcement consists of ½-in. twisted square bars in pairs placed horizontally 2 ft. c. to c., and ½-in. twisted square rods placed vertically 2 ft. c. to c., staggered, the reinforcement being placed 3 ins. from the faces of the wall. For the 6 and 8-in. interior partitions ¼-in. twisted square bars are placed vertically every 18 ins., staggered, and ¼-in. twisted square bars placed horizontally every 18 ins., staggered.

FORMS.—Forms for the slabs were constructed of ¾-in. tongue and groove material and for the beams and girders 2-in. material, dressed on the surface next to the concrete. For bracing

these forms Y-shaped supports, spaced at suitable intervals, were used.

For the columns the forms were made of No. 20 galvanized sheet iron in half cylinders, and bolted together.

For the wall forms 1-in. tongue and groove boards were fastened together with battens, making sections about 3 ft. wide and of convenient length. These sections were placed each side of the wall to be built and held in position by specially designed supports made of two channel irons placed back to back and permanently fastened with a small space or slot between them.

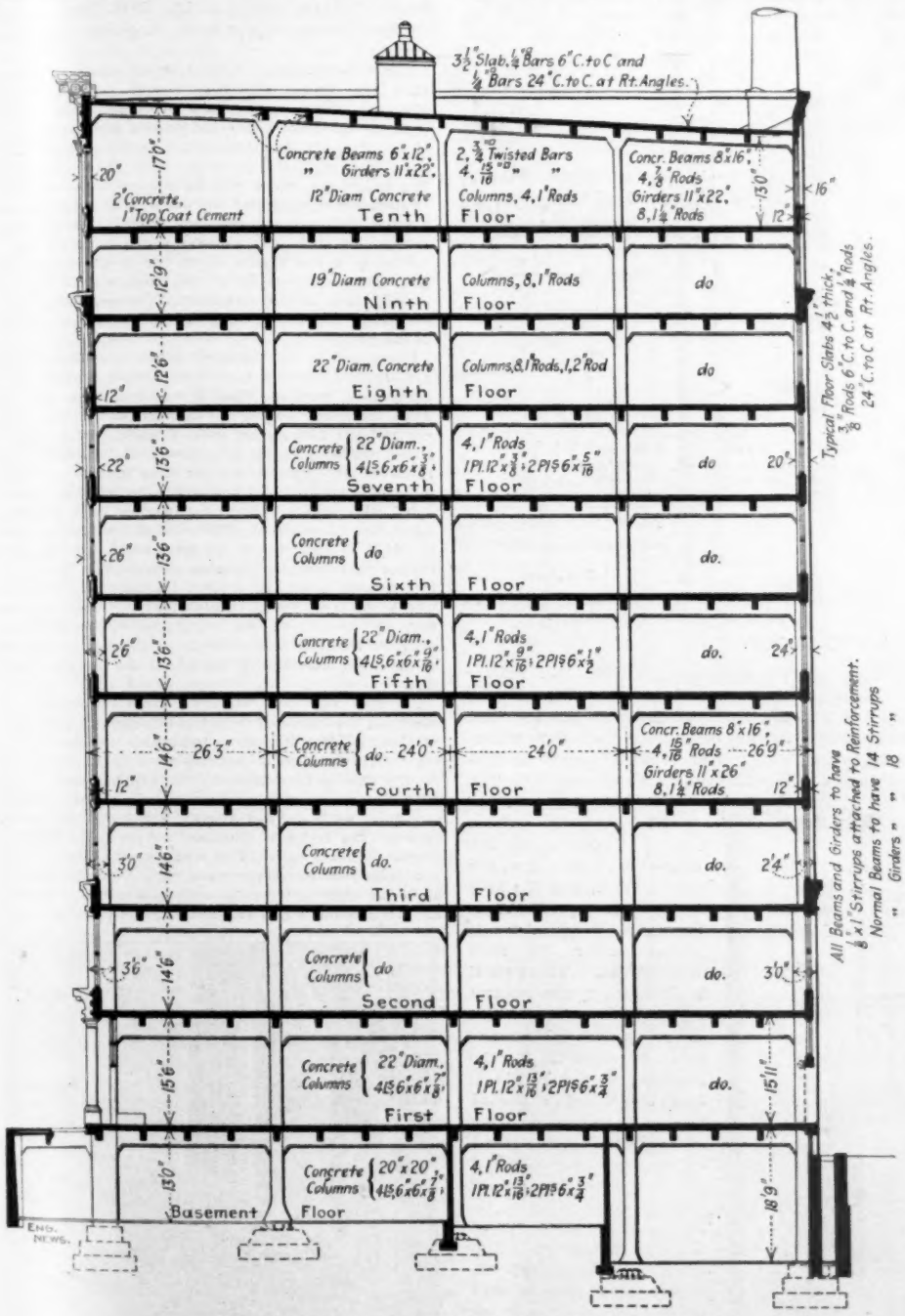


FIG. 2. VERTICAL SECTION THROUGH GLOEKLER BUILDING.

These are placed back of the forms on opposite sides of the wall and held in position back of the form boards by means of bolts passing through the slots in the channels and through the wall. By this means the channel supports are secured in any desired position, the bolts being adjusted vertically in the slots as desired. After a set of these supports have been made, they may be readily used without damage many times, providing an economical method of form construction. Cement block spacers were used between the forms to keep the proper distance apart. These channel uprights may be seen in the halftone in Fig. 7.

STACK, STAIRCASES AND TANKS.—A circular reinforced concrete stack 54 ins. in diameter and 166 ft. high, to meet the requirements of the heating and power plant in the basement, is located inside the building. The stack consists of a cylindrical shell, 5 ins. thick, reinforced horizontally by hoops and vertically by straight rods from its base to the 5th floor, above which it is square. The lower portion, where the heat is greatest, is insulated from the building by means of a surrounding concrete shell.

Communication between the several floors is provided by means of two enclosed fireproof stairways, one at each end and by one passenger elevator running at 150 ft. per min. and two freight elevators each of 10,000 lbs capacity, all electrically operated, and enclosed in fireproof shafts. The enclosing walls are of concrete, reinforced with steel rods as mentioned above. The stairs are of concrete and are monolithic, each flight being designed as an inclined beam with a minimum thickness of 6 ins., reinforced with ½-in. twisted square bars, 6 ins. c. to c. The treads have a 1-in. top surface of cement for a wearing surface. All door openings are protected by tin-clad standard fire doors. Frames for both the doors and windows are of rolled steel, and the window sash glazed with wire glass.

A tank tower of reinforced concrete, 16 × 25 ft. extends 44 ft. above the roof and contains a watertight concrete reservoir of 10,000 gals. capacity, for house supply, and a 20,000 gal. capacity wood tank for sprinkler supply.

An automatic sprinkler system, supplied from the 20,000-gal. sprinkler tank on the roof, and supplemented by a standard fire pump in the boiler room, taking suction from the city mains, will protect the contents of the building against fire. Scuppers emptying outside the building are provided in each story and the floors graded to them to readily carry off any water due to open sprinklers.

The architects and engineers on the work were Messrs. Ballinger and Perrot, of Philadelphia, to whom we are indebted for the information and illustrations given.

WATER SUPPLY AND SEWERAGE OF THE NEW INDUSTRIAL TOWN OF GARY, IND.

When the United States Steel Corporation decided to establish an immense steel plant at a new site on the south short of Lake Michigan, it was necessary to provide residence accommodation for the employees, and for this purpose the new town of Gary, Ind., was established as an important auxiliary to the manufacturing plant. The site was mainly a sandy waste, with the general surface about 12 ft. above the lake, and having a series of ridges from 10 to 20 ft. high. There was no existing settlement to interfere with plans for the new town and its facilities. The public works are designed for a population of 200,000 to 300,000, and are quite independent of the works for the steel plant.

The water supply will be taken from Lake Michigan by a 6-ft. tunnel extending 1½ miles under the bed of the lake, and having an intake shaft with a submerged crib in 40 ft. of water. The crib is 12 miles southeast from the mouth of the Calumet River at South Chicago, which is the nearest important source of pollution. The tunnel will be about 95 ft. below the bed of the lake, in a stratum of hard clay. The Great Lakes Dredge & Dock Co., of Chicago, has the contract for this, but owing to the difficulty experienced in sinking the shore shaft, the actual driving of the tunnel heading from this shaft has only recently been commenced. From the shore shaft a land tunnel 1½ miles long will extend to a pumping station in the town. These two shafts are in about 50 ft. of fine sand (containing water) and 40 ft. of clay. The contract for the pumping plant has not yet been let, as the plant will not be required until the latter part of next year, when the intake tunnel will probably be completed. This plant will be installed in a masonry building forming a prominent feature in the city park. It will be of 20,000,000 gals. daily capacity, and will consist of electrically-driven centrifugal pumps delivering the water to an ornamental water tower of steel and masonry construction, harmonizing with the design of the pumping station. The ordinary pressure will be 50 lbs., with a direct fire pressure of 100 lbs. The electric current will be obtained from a generating plant at the steel mill, driven by gas engines using blast-furnace gas.

There will be about 22 miles of 6 to 30-in. pipe, and nearly all of this distribution system has been laid. The water pipes (and the sewers) are laid in the alleys, but the hydrants are on the streets, one in the middle of each side of each block. Large mains or feeders extend to the limits of the present subdivision for the purpose of supplying future extensions of the town. The pipe system is also cross-connected by large feeder pipes with valves, so that a broken pipe can be quickly isolated without cutting off the general supply of water. During the construction of the intake works, a temporary water supply from driven wells is furnished, the pumps being operated by electricity transmitted from the steel plant at South Chicago.

For the sewerage, the combined system has been adopted, which will also drain the sandy subsoil. The present subdivision, two square miles, will have every lot connected to the sewerage system, and the sewers are designed with

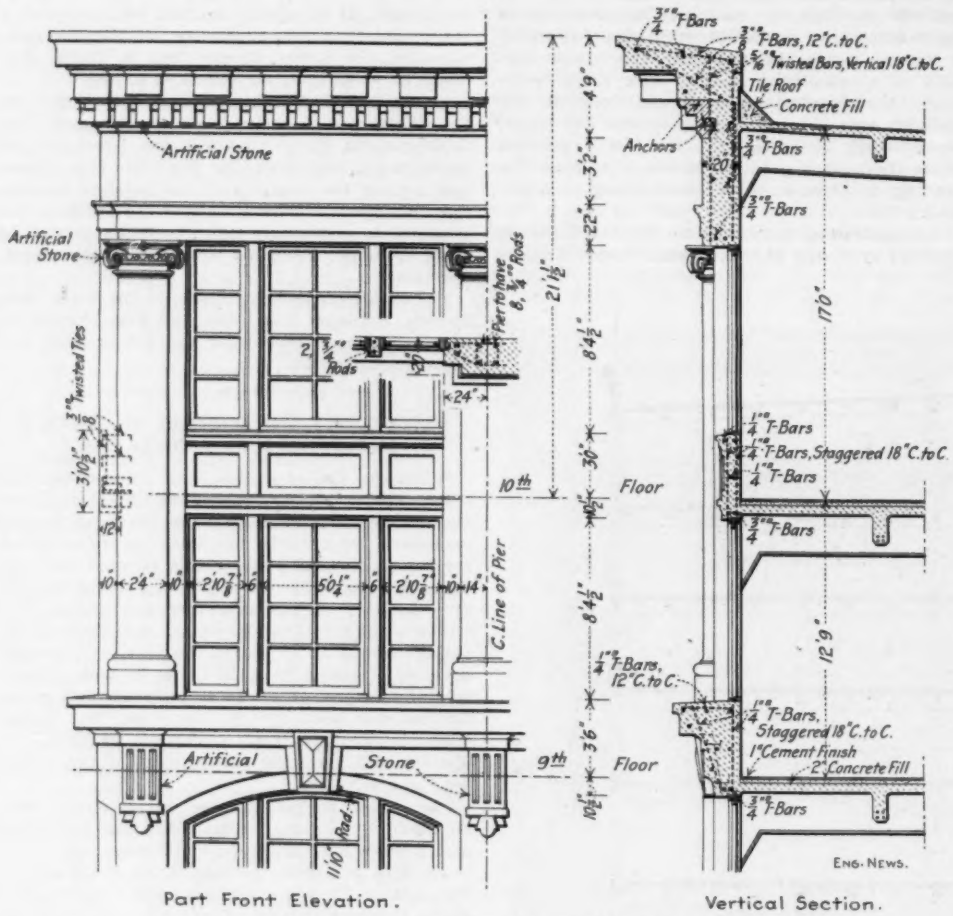


FIG. 3. DETAIL OF WALL AND FLOOR.

a view to future extension. The outfall sewer to the Calumet River is of sufficient capacity for double the present area, and plans have been prepared for draining an additional area of 5 sq. mi. by separate outlets. Plans have also been made for a sewage purification plant, comprising septic tanks and percolating filters. The sewers are 10 ins. to 6 ft. in diameter, at depths of 9 to 23 ft. The depth of the trenches has involved considerable trouble on account of the water-bearing sand, and it has been necessary in several cases to keep the trenches pumped out. The smaller sewers are of vitrified pipe, with cement joints. Those of 24 ins. diameter and upwards are of brick, and the outfall sewer is of reinforced concrete where it passes under the railway yards. There will be 18 miles of sewers, and about 66% of this work is completed. No contract has been let for the sewage disposal plant, and it is not expected that any work on this plant will be commenced before next year.

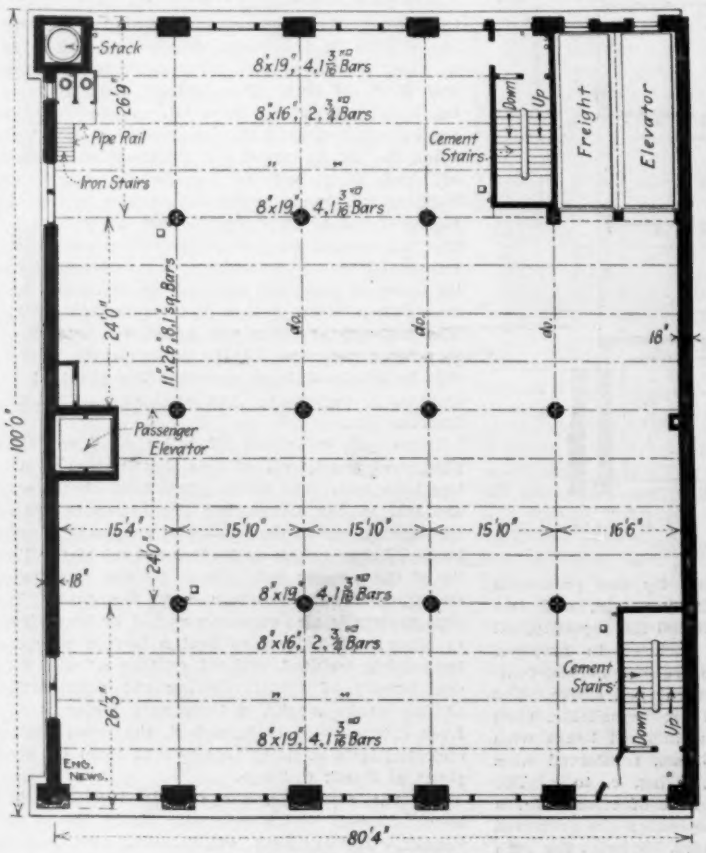


FIG. 4. TYPICAL FLOOR PLAN.

The streets are mainly 60 ft. wide, with 70 ft. and 100 ft. for some of the main streets. The alleys are 20 to 30 ft. wide and in them are laid the sewers, as well as the water and gas pipes. The sewer is in the middle of the alley, and the pipes are about 5 ft. from the property lines. Street drainage is carried off by inlets and catchbasins at the middle of each block. This arrangement removes the drainage from street intersections, and permits the use of a low curb at the street crossings. Opposite each building site the sewer has a stub covered by a removable cap, so that the house connection can be made without breaking the shell of the sewer. Manholes for inspection and cleaning are placed at intervals of about 300 ft.

The engineer for the water supply and sewerage systems is Mr. John W. Alvord, M. Am. Soc. C. E., Consulting Engineer, of Chicago, with Mr. Charles B. Burdick, Assoc. M. Am. Soc. C. E., as his associate in charge of the superintendence of the work. The following particulars of these features of the engineering work are taken from a paper by Mr. Alvord on "The Sanitary Problems of Gary, Ind.," in the 1907 "Proceedings" of the Illinois Society of Engineers and Surveyors:

The water supply of Gary is to be provided by means of a 6-ft. tunnel extending beneath the bed of Lake Michigan, taking water from a submerged intake 7,000 ft. from the shore and conveying it three miles to the center of the city. It is estimated this tunnel will yield more than 60,000,000 gals. per day. From the shore shaft of this tunnel the water will be pumped with transmitted electric power generated by waste gases from the steel plant. The pumping units will probably be centrifugal pumps, motor driven, and the pumping station will be located in a public park in the center of the city. The possibilities of a station of this kind, without boilers or smoke, allow artistic treatment in keeping with the surroundings, and should make the station an attractive part of the park.

Experience in mill towns in which no outside interests are centered shows a general population of about five to every mill worker. That is to say, single men pull down the family average, and supply people, store keepers and the like restore it back again. With 10,000 to 12,000 workers in the completed mills, 50,000 to 60,000 residents are expected, and for these workers two square miles of completed city area are being laid out, and provided with sewers, water, gas, electric light, pavement, sidewalks, all complete. The price of these improvements is added to the cost of the lots, which are there sold subject to reasonable building restrictions. The city is incorporated under the laws of the state of Indiana. It will be governed by its citizens, like any other American city, and is laid out and constructed by the steel company in advance only because of the urgent necessity of providing comfortable homes for the workers in the mill.

The steel mill itself will cover about two square miles adjoining the lake, and is said to represent an expenditure of about $75,000,000. It is interesting to notice in passing that it will have a pumping plant of its own of 100,000,000 gals. daily capacity. The writer is only charged with the design and construction of the water supply, sewerage, drainage and sewage purification of the city proper. The laying of pipes and sewers in the alleyways presents certain difficulties, which are overcome in this particular instance by reserving right-of-way through and along the edges of certain lots for connections to hydrants and catchbasins which are desirably placed in the center

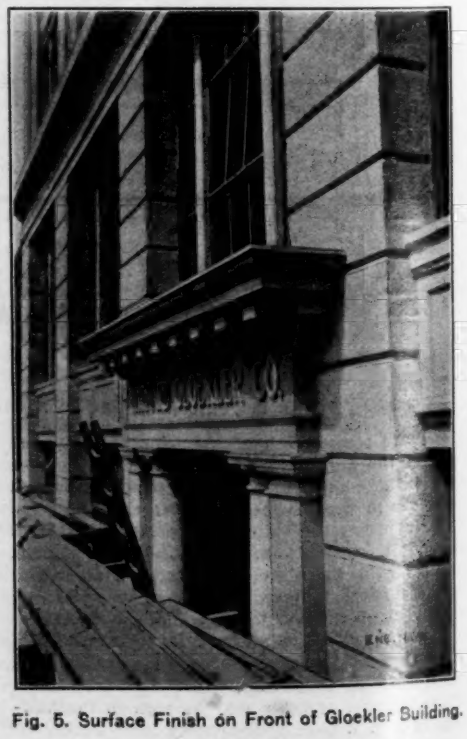


Fig. 5. Surface Finish on Front of Gloekler Building.

of long blocks. This method probably would not be practicable with varied ownership.

The sewerage outlet will be into the Grand Calumet River. This peculiar stream never fully made up its mind where to empty itself. It not only spends a great deal of its time and strength going back to where it started from, but some 30 years ago changed its mind about this even, and gave up emptying itself into Lake Michigan (east of Gary) as it has been wont to do, and now apparently runs up hill from its old mouth to a new outlet at South Chicago, 14 miles away. It is really more of a bayou than a river. Through Gary it runs parallel with and about one mile south of Lake Michigan, and has a minimum flow of hardly 2 or 3 cu. ft. per sec., derived from percolation of the sandy country through which it flows. As there is no other outlet for drainage at Gary, except Lake Michigan, and as that source is pre-empted for water supply, it is evident that sewage purification must be extensively introduced, and this fact controlled the outline and design of the sewers now under construction.

Gary is not on low-lying land, as are Indiana Harbor, East Chicago and Hammond, but the general elevation of the city will be from 18 to 20 ft. above Lake Michigan. The Calumet bayou or river, with a water surface of 1 to 3 ft. above the lake, bounding the subdivision on the north, permits good drainage. The soil is almost exclusively fine lake shore sand to a depth of 40 to 50 ft., and its excellent water bearing qualities caused it to be seriously considered as a possible source of water supply. The final decision to use Lake Michigan for this purpose, compelling the introduction of sewage purification, would seem to point to separate sewers in designing the drainage. A study, however, of the local conditions shows that a combined system would best answer the requirements at Gary. This finally was adopted for the following reasons:

(1) A separate system of sewers, especially if placed deeper than the storm water sewers, would unquestionably be filled with a large amount of percolating soil water in spite of every attempt to make the sewer walls perfectly tight. (2) The porous nature of the sandy soil and the flat character of the country does not indicate a large run-off per unit of area. (3) Observation has shown that a reasonable amount of dilution water in sewage rather facilitates its artificial purification than otherwise, and, at the same time does not require proportionate increase in capacity of the purification plant.

These considerations decided the question in favor of a modified combined system with capacity equal to those drainage systems used in the outlying sandy districts of Chicago. The sewer system at Gary is to empty its flood water into the Grand Calumet River, and have its dry weather flow pumped to a suitable purification site. This decision is further confirmed by two features peculiar to this locality: First, sandy soil for intermittent filtration is plentiful, and the adoption of sedimentation or septic action, followed by intermittent filtration, is indicated as the most economical and advantageous adaptation of the local resources of the district to the purposes of sewage disposal. Second, the operation of the steel plant will cause the waste of about 75 cu. ft. per sec. of more or less fresh water from condensers and other machinery to a point near the mouth of the sewers, and it is believed that this flow will keep the Calumet River in good condition in spite of the occasional storm water overflow from the sewers. The site for the filtration plant and its details have not as yet been worked out, but it will evidently be of considerable capacity.

In connection with the sewerage and drainage at Gary, interesting studies have been made as to ground water percolations in sandy subsoils, both at Indiana Harbor and in the suburban sandy districts of Chicago, and from these studies it is believed that the ground water percolations into the sewers at Gary will not exceed 1,000,000 gals. per day per sq. mile, after the ground water has finally taken its new lower level.

Many interesting and novel questions come up in the design and construction of a new city such as Gary, and one might imagine that there was here presented an opportunity for much better and more original methods of caring for dense population than those which already exist. It is rather interesting, however, to find that the more one looks into the settled arrangements which past communities have worked out for their own benefit, the more one realizes how little one can vary them to any considerable degree without causing undue expense, unexpected inconvenience, or the rise of new and unthought of problems. The general arrangement and growth of cities, and the arrangement of their utilities, as they now ordinarily exist, have been worked out through generations past with a great deal of thought and pains, a sort of revolution which has finally brought them into their present form, and it is safe to say that this general form cannot be altered in any new undertaking without great caution.

THE STREETS OF CHICAGO are in deplorable condition. Alluding to a recent report by W. M. Doherty, Superintendent of Streets, the city has 4,100 miles of streets and alleys, of which only 1,545 miles have been paved. There are 539 miles of old cedar block, all of which needs repaving; 529 miles of macadam (50% needs repaving); 321 miles of asphalt (1½% needs repaving); 92 miles of brick (1% needs repaving), and 51 miles of granite block (1⅛% needs repaving). The only paving that can be regarded as being in good condition is that laid under the 10-year guarantee in 1898. This consists of 612 miles of streets and 22 miles of alleys, and when the guarantee expires next year the city will have to care for this. The report estimates that it will be useless to repair any cedar block paving, and that under present condition $500,000 is required to repair the asphalt streets (exclusive of those on which the guarantee will expire next year), $25,000 for repairing the granite paving in the business district, and $100,000 for repairing macadam paving. There are still 2,600 miles of streets and alleys unpaved, and the paving of these by the Board of Local Improvements is progressing at the rate of only 90 miles a year. The repair work is in some cases delayed by property owners, who have obtained injunctions to prevent the city from proceeding with it. A bill for a wheel tax is now before the State Legislature, the purpose being to tax each vehicle owner according to the number of wheels on all his vehicles and to set aside this as a fund exclusively for street repair work. The mayor has had a count made of the number of vehicles crossing 11 of the bridges in the business district. This was made on Oct. 24, from 7 a. m. to 7 p. m., and resulted as follows: One-horse vehicles, 27,626; two-horse, 15,150; three-horse, 523; four-horse, 63; six-horse, 1; automobiles and motor wagons, 2,070; street cars, 10,916; total, 56,349.

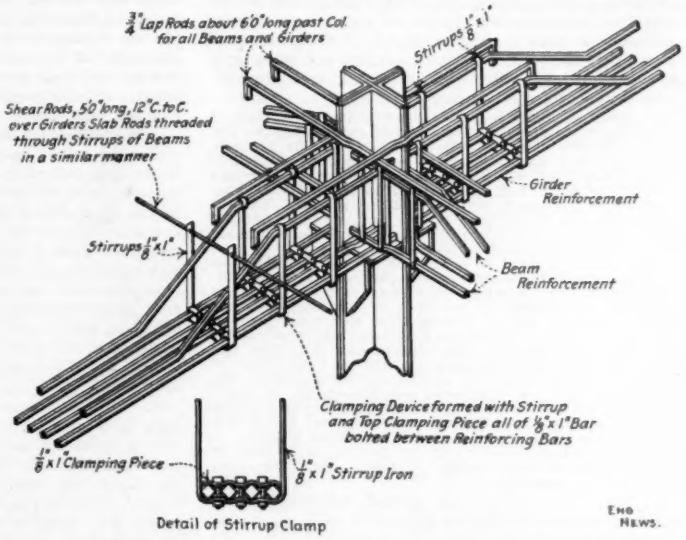

¾" Lap Rods about 60" long past Col. for all Beams and Girders
Stirrups ⅜" x 1"
Shear Rods, 50" long, 12" C. to C. over Girders Slab Rods threaded through Stirrups of Beams in a similar manner
Girder Reinforcement
Stirrups ⅜" x 1"
Beam Reinforcement
Clamping Device formed with Stirrup and Top Clamping Piece all of ⅛" x 1" Bar bolted between Reinforcing Bars
1" ⅜ x 1" Clamping Piece
1" ⅜ x 1" Stirrup Iron
Detail of Stirrup Clamp
ENG NEWS.

FIG. 6. ISOMETRIC VIEW OF COLUMN-GIRDER CONNECTIONS.

A COMPOUND TURBINE working under a head of 285 ft. has been in service at the Wiesberg electric plant, in Tyrol, for some months. The turbine is of the Francis type. The two wheels are on the same shaft, in separate casings, and face in opposite directions, balancing the thrusts. Regulation is by means of pivoted guide-vanes, both sets being under the common control of a single governor. Tests made in April, 1907, gave the following:

Discharge cu. f./sec.	Water Input, HP.	Electric Output, HP.	Efficiency % Total.	Generator.	Compound Turbine.
24.65	800	490	0.62	0.92	0.67
49.75	1,615	1,220	0.75	0.94	0.80
75.60	2,460	1,950	0.79	0.95	0.83½

The tests were made at the normal speed of 342 r.p.m., at a head slightly different from the normal 285 ft., but the results were reduced to the normal head, giving the above figures. [Z. des Vereines deutscher Ingenieure, Oct. 12, 1907.]

STEAM SHOVELS for comparatively light work have been successfully employed on the grading for the Hanover & York interurban electric railway near York, Pa., although as a rule steam shovels are not considered satisfactory or economical for light work. On this road the cuts are only 16 ft. wide at grade and from 6 to 8 ft. deep, with 6,000 to 8,000 cu. yds. in the larger cuts. A 35-ton steam shovel on traction wheels was used, being fitted with a crane or boom giving a lift of 16½ ft. and a reach of 14 ft. With this long lift and reach it could load cars on a track outside the top of the cut in cuts up to 11 ft. deep. This also avoided the spotting of cars from behind the shovel, which is often necessary in making the first through cut. Trains of six to eight 5-yd. Western side-dump cars were used, with a spreader car and locomotive, on tracks of 3-ft. gage. At light cuts, however, 2½-yd. bottom-dump cars were used. Wheeled scrapers were also used for some of the very light cuts. The locomotive was powerful enough to handle its train readily on the steep grades necessary in keeping the dump-car track above the cut. Banks over 6 ft. high were filled from light trestles, which carried only the empty cars. As each car reached the trestle it was dumped and the train pushed forward one car length, the locomotive never running on the trestle. The railway is being built by Dodge & Day, of Philadelphia, and the special steam shovel was built for them by the Vulcan Iron Works Co., of Toledo, Ohio.

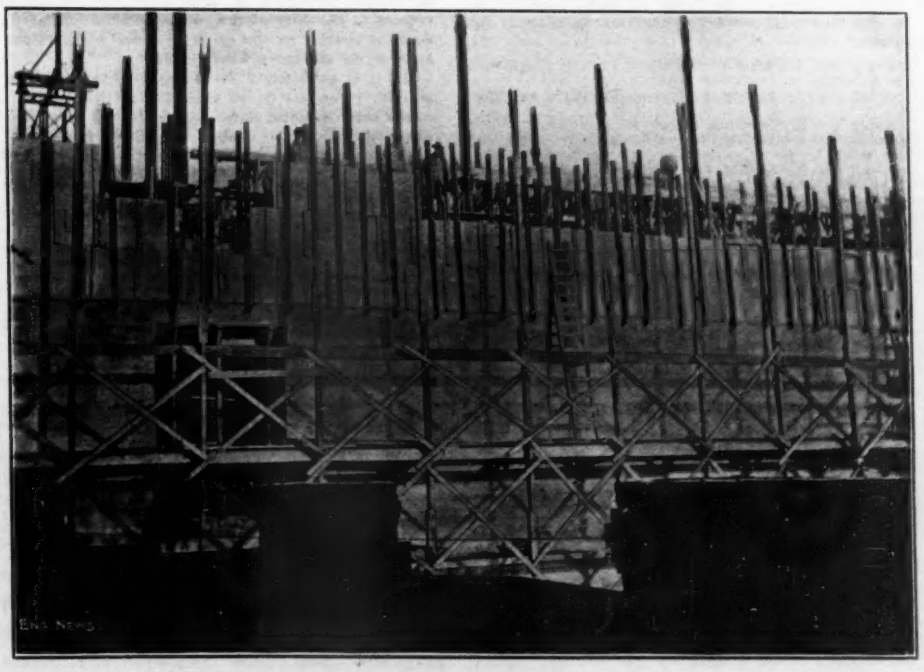


FIG. 7. CHANNEL-SECTION CONCRETE FORM UPRIGHTS USED ON GLOEKLER BUILDING. THE SOUTHERN RY. FREIGHT YARDS.

REPORT OF THE TRANSVAAL COMMISSION ON THE USE OF WINDING ROPES, SAFETY CATCHES AND APPLIANCES IN MINE SHAFTS.

(*Continued from our last issue, page 465*)

Winding Ropes (Preservation).

56. All evidence goes to show that the preservative treatment of a rope during its manufacture is a matter of the highest importance, and has a considerable influence on the life of the rope. The core, of tarred Russian hemp, should be thoroughly soaked in an acid-free lubricant. The wires should also be well lubricated while they are being "laid-up," and the whole rope then, if the dressing is sufficiently thick and heavy, is well prepared to resist the corrosive action of a damp atmosphere. For shipment abroad, ropes are usually coated with a black (plumbago) varnish; such a rope should be well treated with a lubricating dressing before being put to work, and this is a wise plan to adopt with all winding ropes.

57. Regarding the composition of a suitable dressing, there are several recipes put forward. Most manufacturers favor plumbago, or graphite mixed with vaseline, linseed oil, palm or other vegetable oil. Three riggers, who gave evidence, differed entirely on this point; one favored Stockholm tar with grease, a most objectionable compound; another favored a mixture of one part cylinder oil to two parts of truck grease, while the third was in the habit of using a patent composition.

58. A table from Messrs. Vaughan and Epton's paper, giving in condensed form information relative to various rope, dressings, is given in this connection.

59. The following extract from the "Queensland Government Mining Journal" of January, 1907, is quoted here as being a clear instance of a rope having been ruined through the use of an unsuitable lubricating dressing:

Recently the manager of the Bluff Colliery, Central District, who had experienced difficulty through breakages in the wire rope in use at the mine, forwarded to Brisbane a sample of the water, which he considered the cause of deterioration in the rope. He mentioned that the lubricant used was Stockholm tar, tallow, and resin. At his request, the Mines Department had the water analyzed, and the report of the Government Analyst (Mr. J. Brownlie Henderson) on the subject is as follows:

"I have the honor to report that the sample of water received from you contains no free acid, except the carbonic acid present in all natural waters. I do not think it is necessary to look for the cause of corrosion in the mine water. The lubricant used for the rope is undoubtedly the cause, and a more objectionable lubricant than the mixture of Stockholm tar, tallow and resin which was used, either from a physical or chemical standpoint, could hardly have been applied. Stockholm tar always contains acetic acid, and I recently had a sample which contained nearly 10% acetic acid. Tallow readily becomes rancid, and then contains free organic acids. Resin is mainly an organic acid. The Stockholm tar is the worst ingredient, and it alone would soon destroy any wire rope."

60. It should be pointed out that if a rope dressing is used which hardens on exposure to the atmosphere, care should be exercised to see that the pit-head sheave is kept cleaned out in the groove of the rim, as it has been proved by more than one accident that the winding rope can be thrown off the sheave by reason of accumulation of hardened lubricant in the tread.

61. Mr. A. McArthur Johnston, Metallurgical Chemist of the Consolidated Gold Fields of South Africa, Ltd., gave the following results of analyses of several rope dressings:

Dressing No. 1.—Acidity equivalent to 0.19% sulphuric acid.
Dressing No. 2.—Acidity equivalent to 0.21% sulphuric acid.
Dressing No. 3.—Contains traces of alkalinity.
Dressing No. 4.—Acidity, traces (less than 0.01% sulphuric acid).
Dressing No. 5.—Acidity equivalent to 0.30% sulphuric acid (of this acidity, mineral acid accounts for 0.11% sulphuric acid). This preservative also contains finely divided graphite substance.
Dressing No. 6.—This would seem to be petroleum jelly (vaseline), flavored with a little nitro-benzine. It is free from mineral acids.

62. It is obviously desirable that rope dressings should be free from acidity, and, from the quoted results of tests, it appears absolutely necessary that tests should be made from time to time *by qualified persons* to see that this freedom exists.

63. A good rope dressing wards off corrosion and reduces frictional wear. It should be applied every fortnight in dry, or nearly dry, vertical shafts, but more frequently in inclined shafts on account of its being rubbed off by friction sooner. In wet shafts the dressing should be applied weekly, or even oftener if found to be necessary from the condition of the rope. The dressing should be applied hot to the cleaned rope, by slowly passing the latter through a box containing the composition. Mr. J. M. Wright exhibited a model of a mechanical rope-cleaning and oiling machine, but no opportunity offered to try the device under working conditions. A simple machine should certainly tend to secure the regular and thorough cleaning and dressing of the winding ropes. Mr. J. B. Pitchford, in a contribution to the evidence, states:

In order to make a proper examination of a rope, it is necessary to clean it properly and remove all the tar, etc., from the wires, leaving them as bright as possible. One method of doing this is to pass the rope through a trough of hot oil, which removes all the tar. The trough is made of steel, and can be from 15 ft. to 30 ft. long. It is of "U" shape in section, and has a steam space of 1¼ or 1½ ins. around the bottom and sides. It is fitted with a relief valve and a drain, so that the condensation can be taken to the hot-well.

The trough is filled with oil and heated, and the rope to be cleaned is passed slowly through it under depression pulleys, by being wound from one rope drum to another. By providing two sets of rope-handling engines, the rope can be passed back and forth through the oil until it is quite clean enough for examination. The rope-drum engines are so arranged that they can wind the rope over the headgear sheaves from either of the winding engines. The drums can be moved on the shaft to bring them in approximate alinement. By having a spare rope, the work in a shaft need not be detained for rope examination, the only time required being that necessary to unwind one rope and to put on another.

Similar arrangements to these were used a number of years ago at Virginia City, Nevada, where flat ropes were used extensively.

64. With reference to the possible deleterious effect of working conditions on the life of the rope, one manufacturer remarks:

A winding rope, made to suit the special winding apparatus at a mine, should depend only upon the number of foot-pounds of work done for its life. The more material lifted from the mine, or the quicker that it is lifted, has a factor upon these foot-pounds in direct proportion to the life of the rope.*

While the statement is doubtless theoretically correct, it has been found in local experience that practical difficulties exist in the manufacture of a winding rope that will absolutely suit special working conditions. There may be a combination of adverse factors such that any provision made to combat the one only tends to weaken the defense of the other. For instance, in a compound shaft (partly vertical and partly inclined), the large frictional wear due to the guide-sheaves in the bend and the rollers on the incline naturally point to the use of large outer wires in the strands of the rope; but if the winding drum is of small diameter, the maker might well hesitate to do this. Speaking broadly, it may be said of winding ropes on the Rand that the working conditions have such an effect on their lives that comparison in respect to the duty of the rope is seldom attempted, except, of course, in the cases of ropes which follow one another on the same winding plant.

65. It is quite usual for the rope to be wound in several layers on the drum, especially in the cases of some of the older winding plants which are now being used for considerably greater depths than those for which they were designed. Where heavy loads are hoisted, and the smaller diameter of the drum leads to the use of ropes of compound construction, there occurs very severe and rapid wear on the rope, due to crushing and pinching actions. In several such cases it has been found that a rope of "best crucible" steel of about 100 tons breaking stress proves to be the longest-lived, although it is more unfavorably conditioned with respect to statical loading and bending stress than the ropes of other constructions.

66. Variation in the direction of shaft also introduces a very destructive influence. Of the shafts on these fields in which raising and lowering of persons is permitted, there are 89 vertical, 56 inclined, and 34 compound. The compound shafts are, in nearly every case, graded vertical to inclined, and the turn is made on a bend of fairly large radius, varying from 50 ft. to 170 ft., and, in some cases, even up to 600 ft. The rope in going around the bend is guided by a series of seven or eight wide rollers. These rollers, to minimize inertia effects, are generally made up of a series of narrow, flat-rimmed sheaves, threaded on the same spindle with designedly but slight clearance between adjacent sheaves. Inertia troubles, however, are never got rid of completely, and the spacing of the sheaves widens with wear, and has been known to allow the strands of the rope to be pinched between the rims.

67. The rollers on the inclines are not always moving freely, and the gritty dust that hinders their successful operation also causes the rapid wearing away of the wires of the rope. While this wear is evenly distributed over the circumference of the rope, it is not nearly so dangerous as when it occurs, as it sometimes does, near the attachment to the skip, in a one-sided manner, perhaps nearly severing an individual strand of the rope. Uneven deterioration in one particular part of a winding rope is a particularly dangerous defect, as the equal distribution of the load among the component wires is disturbed, and the danger of actual fracture is more nearly approached.

68. The rollers should be of the lightest possible design, well balanced, and of sufficient size to prevent excessive speed on the wearing spindles. No matter how well designed, they still have the effect of shortening the life of the rope, as it is impossible to keep them always in the best working condition, owing to grit, acid water, etc. This no doubt accounts to some extent for the shorter life of many of the winding ropes in inclined shafts on the Witwatersrand, as compared with ropes working in the vertical shafts of coal mines, where such severe conditions do not obtain.

69. Evidence was taken as to the advantage or disadvantage of using rests (keps) to facilitate the loading of the conveyance. Nearly all the witnesses were opposed to the use of keps, although acknowledging that they are probably necessary where a cage is used and truck loading is in vogue—especially so in the case of deep winding. Up to the present they have not been proved necessary for skip loading, even in very deep shafts. On the majority of the Witwatersrand mines they are certainly not necessary, and, if installed, would constitute a source of danger if used anywhere else in a shaft than at the lowest loading stations. Apart from any such danger, the general objection to the use of keps is that they shorten the life of the rope by introducing more severe alternation of the loading of the rope than is necessary, and lead to a pick-up shock which is greater than the shock of loading with the rope hanging taut. They are not recommended, therefore, as their use increases the risk of accident and they are harmful to the rope.

70. With reference to the question as to how far the rope is affected by the speed at which hoisting is carried out, rapid winding is considered to be the more harsh condition; and the opinion was expressed by several witnesses that slow winding with big loads will give longer life to the rope than quick winding with small loads. This is not on account of the fact that the average speed is higher in one case than the other, but

*This last sentence, a trifle obscure, is evidently intended to say: "The amount of material lifted, and the rapidity with which it is lifted, are the factors which determine the life of the rope."—Ed. Eng. News.

TABULATED PARTICULARS IN REGARD TO ROPE DRESSING USED AT NINE MINES.

Distinguishing No.	Put on hot or cold?	How often put on?	Does it run down the rope when rope is hanging in Shaft?	Does it harden?	Does it leave wires when rope is wet?	Composition.	Results of Tests in Mines Department Laboratory.	Further Remarks—Mechanical Laboratory.
74	Hot	Once a week	No	Yes	Yes	Stockholm tar	Not tested	.....
75	Hot	Once a week	Yes	No	Yes	Anti-friction grease and Stockholm tar	Practically neutral; if anything, a tendency to alkalinity	Runs off, and does not penetrate rope
76	Hot	Every 2 weeks	No	Yes, but does not peel off; becomes elastic	No	Unknown	Quite neutral, and appears to consist solely of vaseline with a little graphite	Remains soft, penetrates rope, and does not run off.
77	Hot	Every 3 weeks	No	Yes	Yes	Unknown	Neutral, and appears to consist solely of vaseline with a little graphite	Remains soft, penetrates rope, and does not run off.
78	Cold	Once a week	Yes	No	Yes	Stockholm tar and raw linseed oil	Decidedly acid, and on shaking with water gives a strongly acid solution; contains also creosote	Runs off and does not penetrate rope
79	Hot	Once a week	No	Yes	Yes	Unknown	Slightly acid; contains creosote	Sets hard, and does not penetrate
80	Hot	Once a week	No	No	No	Anti-friction grease, mineral oil & graphite	Very faintly alkaline to litmus	Remains soft, penetrates rope, and does not run off.
81	Hot	Once a week	No	Yes	Yes, after about a week's run in wet shaft	Patent Composition with Stockholm tar, tallow, and graphite added	Distinctly acid	Very thin; remains soft, penetrates rope, but has a tendency to run off.
82	Hot	Every 2 weeks	Slightly	No	No	Unknown	Practically neutral	Remains soft, penetrates rope, and does not run off.

because of the existence of a greater liability to shocks due to sudden changes of velocity.

71. In order to minimize the bad effects of rapid winding on the rope, it is necessary to have the pit-head sheave as light as possible and the winding drum massive, so as to moderate the shocks in starting and stopping. With a heavy sheave there is a tendency to wear the ropes very severely at the points of acceleration and retardation, owing to the ropes skidding when the velocity of winding changes quickly. In a well-designed winding plant it should be possible, with careful driving and good governing, to avoid sudden large alterations of speed. A good speed indicator, such as a recording tachometer, is likely to conduce materially to the smooth running of the cages, both from the assistance it gives to the engine-driver and from the check that it provides on the manner in which he performs his duty.

72. Where small winding drums are used to carry several layers of rope, very severe damage is frequently caused owing to the "pinching" effects that occur at the cheeks (flanges) of the drum, where the winding rope is forced by wedge action to turn backward on itself in a riding turn. This can be obviated if the flanges are constructed to a design introduced by Mr. H. C. Behr, Consulting Mechanical Engineer to the Consolidated Gold Fields of South Africa, Ltd. In his standard specification for winding engines, as mentioned in Mr. E. J. Laschinger's evidence, it is provided that:

"The last groove opposite to where the rope is attached shall rise gradually above the other grooves, so as to raise the second layer of the rope gradually, and without shock, above the first layer. In order to prevent overstraining the drum flange, or wedging the rope as it mounts from the second to the third layer, where it cannot be assisted by a rising groove in the drum as employed in the case of mounting the rope from the first to the second layer, the drum flange at that point shall be formed with an annular projection sloping at an angle of 45° for the depth of the second layer of rope. Below the sloping part there must be a filling piece shaped along a spiral, so as to fill the space between the edge of the rope and the lower edge of the conical projection of the drum flange, for the purpose of preventing the end of the second layer of rope from being wedged in between the first layer and the foot of the flange."

73. Side friction of one coil of rope on the next coil, as also on the lower coils on which it is bedding, may be produced by too short a lead from the pit-head sheave to the drum. The angularity of the pit-head sheave and the horizontal distance of the drum from the shaft should so conform to the width of the drum that the deviation of the rope is not too great. An angle of 2° on each side of the center line has been found to be sufficient. If this limit is departed from to any extent, there is considerable side friction on the rope, and the coiling of the rope on the drum is likely to give trouble. However, in the case of a grooved drum with the rope coiling in only one layer, it may be permissible to have more lateral deviation.

74. Practically all the evidence tendered was in favor of the view that periodical re-capping materially increases the life of a winding rope, from 10% to 30% being the estimates of the gain resulting from the regular practice. Each time ten or twelve feet are cut off from the lower end, the whole working part of the rope is shifted that amount towards the conveyance, and the positions of greatest wear are thereby altered—with the exception, however, that any local damage that exists in the rope due to "pinching" at the flanges of the drum, is not prevented from increasing. To change the wear from these places, it is necessary to alter the position of the attachment of the drum end of the rope, or to slack out this end should there be spare rope carried inside the drum.

Winding Ropes (Examination).

75. The absolute necessity for a daily examination of each winding rope by a competent person is a point on which all witnesses agree. The Commission also recommends a weekly examination on the following lines:

76. The person making the examination stands in a safe position at the collar of the shaft and allows the rope to be slowly raised or lowered through his hand, which is protected by a thick glove or piece of waste. The rope should not be moved faster than forty or fifty feet per minute; and, while feeling with the hand for any broken wires, the eye of the operator watches closely for any other defects, such as excessive wear, loosening of the strands, straightening of the lay, kinking or severe corrosion. When anything abnormal is noticed, the motion of the rope should be stopped and the suspected part thoroughly cleaned and examined. If the defect is a serious one, such as the occurrence of two or more broken wires in a short length of the rope, say two feet, the engineer's attention should at once be called to the fact; while, in the case of a lesser defect, a note should be made of its position in the rope, a proper entry logged in the record book, and the engineer duly informed. It is also advisable that the rope should be watched for a short time while it winds on and off the drum and while coiled on the drum, so that the positions of possible pinching or crushing can be located and examined.

77. A few of the witnesses were of the opinion that the daily examination of the ropes was not regularly or properly carried out, and others spoke of the difficulty in finding time for it. There appear to be difficulties in the way of setting apart a particular time of the day in which the rigger or other person detailed for the work, shall have the rope and winding plant at his disposal. This Commission, however, feels strongly that the regulation which provides for the daily examination of the ropes that raise or lower persons should be enforced with the utmost stringency. The withholding of facilities for the carrying out of this examination should constitute an offense against the regulations, while, on the other hand, the penalty for making a false entry in the record book should be most severe.

78. The proposal was made to the Commission by the three riggers who gave evidence, that the rigger (or wire splicer) who carries out the daily examination, and who, under the supervision of the mechanical engineer, has sole charge of the winding ropes, should be certificated; that is to say, he should pass a practical examination under Government ægis to ensure his competency. The Commission has not not gone deeply into this question, but regards it as one worthy of the serious consideration of the Government. It has to be noted, however, in this connection that the mechanical engineer, who is responsible under the Regulations for the monthly examination of the rope, in accordance with recent amendments,* has to be the holder of a certificate of competency. In the Syllabus of Subjects comprised in the Examination Scheme, "Wire Ropes—their Structure, Inspection, and Maintenance," finds a place. So that it appears probable that this member of the staff of the mine, who actually engages and supervises the rigger, will be quite able to decide as to his competency or otherwise.

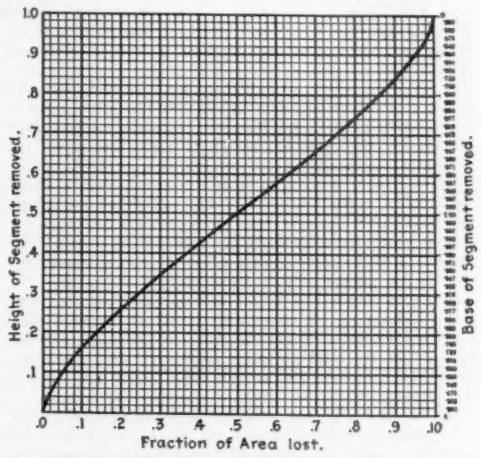


Diagram for Graphical Estimation of Reduction in Size of Cable Wires Due to Wear.
(See Paragraph 84 of Report.)

79. A good deal of evidence was given in favor of making the "thorough" examination of the rope a weekly duty, as contrasted with the present monthly practice. This proposed alteration of the regulations is not recommended by the Commission, the necessity for the change not being considered to be established. The monthly examination appears to be designed for the purpose of carefully gaging the progress of normal wear and assessing the probable strength remaining in the rope, while the daily examination is emphasized in importance as being the one which is relied upon, and that practically entirely for the detection of abnormal and unforeseen deterioration. The functions of the two examinations, although related, are very far from similar.

80. When a rope has been working for some months, or when there are signs of rapid deterioration, the engineer will naturally make his thorough examination more frequently—every fortnight, or even once a week. This contingency appears to be anticipated in the regulation which reads "At least once a month, etc."†

81. To clean a rope for thorough examination, certain mechanical devices were suggested, the idea being in each case to pass the rope through a box containing scrapers or revolving brushes. In one case a trough of boiling oil was suggested. These devices have been alluded to in paragraph 63 of this report.

Most persons appear to consider it unnecessary to clean the whole rope thoroughly, and it is doubtless quite sufficient for the purpose of even thorough examination to clean the rope at selected places by means of the usual appliances, viz., a stiff wire brush and paraffin or oil, according to the preservative composition used on the rope.

82. The portions of a rope that should be most carefully examined will generally be well known to the mechanical engineer from his experience with preceding ropes, and the knowledge of why and where they deteriorated most. With respect to external wear, the places in the rope that should be especially watched are those where contact with the pit-head sheaves or heavy guide pulleys occurs at acceleration or retardation periods of the hoist. These places are also likely to suffer more than any others from internal wear, excepting perhaps that portion of the rope near the skip or cage, which, although generally subjected to no rubbing wear, yet is exposed to the corrosive effects as well as to the bending and shock stresses. In addition to these positions, attention must also be directed to that part of the rope which lies between the drum and the sheave when the load is at the bottom of the shaft, as also to those parts of the rope which come in contact with the flanges of the drum.

83. On p. 170 of the oral evidence are given particulars of the tests of three worn ropes. These ropes had been discarded by the mine authorities, and it was therefore possible to cut them up and obtain samples showing the condition of the rope at various points. One of these ropes, the original breaking strain of which was 62.5 tons, broke at loads varying from 46.1 tons to 47.9 tons. This rope had only been in service 7½ months, and was discarded owing to a bad kink. Another similar but longer rope broke in various places at loads ranging from 36.0 to 53.8 tons. The third rope, of 1½-in. diameter and originally of 105 tons breaking load, broke at loads varying from 74 to 89 tons. The results of these tests bear out what has been said previously regarding the positions of probable maximum deterioration.

84. Opinions are equally divided as to the necessity of relieving the rope from the stress of its load during the examination. For taking circumferential measurements at various positions on the rope, so as to compare wear, it is certainly not desirable; but for the purpose of internal examination it is absolutely necessary. Slack strands or wires, or straightening of the lay, where such occur, can generally be seen under ordinary working conditions. With respect to the calculation of wear by means of circumferential measurement, the following extract from Messrs. Vaughan and Epton's treatise may be quoted:

> In estimating the reduction of the size of any wire due to wear, the accompanying diagram may be of some assistance. This diagram shows the fractional area of circle remaining after a segment of known base and known height has been removed. Taking the diameter of the circle as unity, there are for each value of the base two values for the height, one greater than 0.5 and one less than 0.5. There should, however, be no uncertainty or error due to this cause, as it is a fairly easy matter to see whether a wire is half used through or not. The length of the base of the segment worn away can be measured by one person examining the rope after the removal of any side "burra."
>
> To estimate the height of the segment worn away in a portion of the rope which is fairly uniformly worn, the writers advise a comparison of the circumference of the rope at this place with the circumference at some other place at either end of the rope where there is little or no surface wear, while at the same time there is some reduction in size of the rope due to untwisting and stretching under the working load.
>
> To measure these circumferences, wrap a fine wire or unstretching cord ten times around the rope in each case. Dividing each measurement by 10, the true circumferences are found, from which, by reference to tables, the diameters of the rope at the two places under comparison may be arrived at. Subtraction of these diameters should give approximately twice the height of the segment of wire removed by wear.
>
> If the approximation is nearly correct, and if the base of the segment has been correctly measured, these two values, height and base, must lie at the ends of the same horizontal line in the diagram. If they do not, there is some error and one must try again. If they do, the point where this horizontal line cuts the curve indicates the fraction of circle remaining and also the fraction that has been worn away.

85. Dealing now with methods of assessing the deterioration of a worn rope, other than by the examination of the separate wires of a piece cut from the end at the time of re-capping, it appears correct, in the case of a rope of simple construction, such as 6.6.1, to state that if the wear evident externally is taken into consideration—neglecting the deterioration that may possibly exist internally—a fair idea of the strength of the rope will be arrived at. If, however, corrosion is to any appreciable extent visible externally, it will be wise to assume that it also exists on those parts of the wires which cannot be seen.

In a rope of compound construction, the possible condition of the internal wires has to be considered, and this makes the calculation more difficult and naturally more of the nature of a guess. A point of possible assistance is the fact that in a rope of this description, when the internal wires are corroded, this generally has the effect of loosening the strand somewhat, and the outer wires are "standing up," or probably can be raised up or pushed aside so that the condition of the inside wires can be seen.

86. Most witnesses agree that internal wear or corrosion is very difficult to discover, but some suggest that by untwisting the rope slightly the condition of the wires on the underside of the strand can be seen. This can be done by means of two twitches and levers, and it is maintained that the strands of the rope can be closed into their normal positions again without injury. Several witnesses were strongly adverse to this opening out of the rope, and it appears fairly certain, in the case of a well-worn rope, that the strands would not naturally return to their places. It stands, therefore, as a procedure not to be recommended except in exceptional cases, where internal corrosion is known to exist and must be gaged and where the user of the rope is prepared to discard it if damage is occasioned thereby.

*See Section 1, Mining Certificates Amendment Ordinance, 1906. Government Notice No. 1232 of 1906.

†We shall publish, later, extracts from the Mining Regulations of the Transvaal.

The use of a marlin spike was also advocated by one or two practical witnesses, to open up the rope for internal examination. While it is possible that in the hands of a wire splicer of large experience this method might be safe, the great possibilities of dangerous damage being done to the rope by a less skilled person absolutely condemn what, it is trusted, is not a practice.

Winding Ropes (Best Method of Testing).

87. In dealing with the important matter of how best to ascertain the true strength of a new rope, the weight of evidence is in favor of a tensile test to destruction of a sample of the whole rope. It is true that some manufacturers state that the true breaking load can be calculated from the aggregate strength of the wires; but there still exists a considerable diversity of opinion among these experts as to the percentage reduction that should be made from this total to take account of the fact that the wires, when laid up in the form of rope, are not in a position to give out their full efficiency. One manufacturer advises a deduction of 8½%, while others state 10% to 12%. There is also a lack of agreement as to whether or not these deductions should vary according to the construction of the rope. As a practical acknowledgment of the inaccuracy of these assessments for use generally, it is found that the majority of the manufacturers who export ropes to the Transvaal prefer to give the strength of the rope as the aggregate of the strength of its wires, and allow the purchaser to make any deduction he may think proper.

88. Mr. Epton, after a large number of tests of new ropes of various manufacture and construction, found that a difference of from 3% to 10% existed between the aggregate strength of the wires and the breaking load of the rope. Thinking that this loss of efficiency might disappear after the rope had been well tightened in the course of a few weeks' use, some further tests were made under these conditions. The results point to the fact that this efficiency is not regained.

89. Seeing that it is highly desirable in the interests of safety that the real breaking load of a new rope should be known in preference to the theoretical ultimate strength, the Commission is led to the conclusion that the only correct method is to test a whole sample of each new rope before it is put into use; that is to say, each new rope should be delivered to the purchaser accompanied by a test certificate which, if not obtained in the country of origin, should be procured from the Government Testing House in the Transvaal, duplicate certificates being allowed for separate portions of the same coil.

90. As to the length of rope required for such a test, opinions vary; some witnesses saying that a length of two feet is sufficient, while others consider that it is necessary to use at least ten feet; but from experiments made in the Transvaal Mines Department Mechanical Laboratory, very little difference appears to exist even in these limiting cases. The results of comparative tests between long and short samples of two ordinary winding ropes have been made public by Mr. Epton. In one case there was practically no difference; and in the other case, in which a length of 4 ft. 4 ins. was compared with a length of 14 ft. 10 ins., a difference of 900 lbs. in 50 tons was found, this being in favor of the short test length.

91. Several different methods of holding the whole rope specimen during test appear to be in vogue, but the best and most frequently used in public test houses is to open out, clean and tin the wires, and then run on a soft, white-metal conical seal. In the Mines Department Laboratory it is the practice to use an ordinary commercial white metal which has a melting point of about 375° F., and which has been found not to damage the wires in the least degree.

92. It is considered a proper practice to apply to the individual wires of a rope other standard tests, such as tension, torsion and bending tests. These are very useful to mark down a very inferior wire, or to show up large departures from uniformity.

93. To determine the strength of a winding rope during its working life, the evidence taken appears to show that the best method is to re-cap the rope at intervals of from three to six months, and to have a portion of the rope cut off for testing purposes. It is also strongly advised to examine the wires thoroughly at the same time, by means of a magnifying glass or microscope, for corrosion or any other deteriorating influence. It would be more correct to make the interval between successive re-cappings dependent on the duty of the rope, but this course is obviously impracticable. The mining regulations of the Transvaal provide for regular re-capping, not more than six months being allowed to elapse between successive re-cappings in the case of a round rope, nor three months in the case of a flat rope.

A portion of the rope cut off, in length not less than half the circumference of the pit-head sheave, must be sent to the Government Mechanical Laboratory for testing. The practice followed in the laboratory is to furnish a certificate of the actual breaking load of the specimen, and at the same time to call the attention of the mine manager to any defects, such as brittleness, corrosion, want of lubrication, etc. This practice is in every way commendable, but we would recommend that the six-months' period should apply also to flat ropes, which are no more difficult to examine than round ropes.

94. A question was asked in Schedule 2 with reference to the utility of an elongation test of the whole rope, from time to time, during its working life. Opinions seem to be about equally divided on this point. Some witnesses think it would be an advantage at stated intervals to ascertain the stretching power of the rope when hanging in the shaft, by applying its usual working load or something in excess of this. Others think that no useful purpose would be served and that certainly loading in excess of the normal conditions might do damage.

95. Professor Joseph Hrabak, of Pribram, carried out some interesting experiments to determine the elongation of wire ropes under known loads, and thus to find out the modulus of elasticity. He refers fully to these in his book "Die Drahtseile," and from the description of his tests it appears that the data were arrived at by loading the cage with men in many deep-level vertical shafts, and noting the elongation thus produced in the rope. In a 3,000-ft. shaft the elongation amounted to about one inch per man, and it is therefore possible to measure it reliably and accurately. The modulus of elasticity of a winding rope will vary during its working life, being small at first, and afterwards increasing to something nearer the value of the modulus of the wire itself; and then, if the rope is kept in use long enough, it will probably decrease. This last effect, if observed, is to be taken as a danger signal, pointing to the deterioration of the rope.

96. On the whole, the Commission considers that the practice of making elongation tests of the whole rope is to be recommended, but that the ordinary working load should not be exceeded to more than the extent of doubling the authorized load of the skip or cage.

97. It is also strongly recommended that when a winding rope is taken off, and its life considered ended for the particular purpose for which it was installed, a sample from the most worn place should be tested. The results of these tests should prove of the greatest service to the person who has had charge of the rope, as they would enable him to see how far his judgment was sound concerning its condition. It is not recommended that this practice should be made compulsory, for the reason that it would probably involve in most cases the wrecking of any utility that the rope might still possess for purposes other than that of transporting persons.

98. A very important question arises in this section of the Commission's investigations, as to what loss of strength a rope has sustained owing to the removal by friction, etc., of a certain definite proportion of the cross-sectional area of the wires. To come to any sound conclusion regarding this matter, it is necessary to know what support is afforded to any individual wire by the gripping tendency of the adjacent wires. Mr. Epton, in his evidence, submitted the results of tests conducted by him of two rope samples, 26 ins. in length between the grips, each specially prepared by having ten of the outside wires cut through. These tests showed that the supporting effect of the sound wires on the broken wires amounted practically to nothing. These rope samples were new or only slightly worn.

99. Of 91 complete tests of worn ropes carried out in the Mines Department Mechanical Laboratory, 33 show that the laid-up wires have a greater strength than when tested individually at the most worn part, and 49 show the opposite; while 8 give almost the same results, whether tested as separate wires or in form of a rope.

It is interesting to note that the great majority of the ropes which tested higher than the aggregate of their wires were of the simple construction, viz., six strands of seven wires, 6.6.1. All these results go to show that in a short length of rope—two or three feet—the strength of the rope cannot fairly be assumed to amount to more than the aggregate strength of the wires, estimated in each case at the position of greatest wear, although these positions may not all occur at exactly the same point in the rope.

Mr. Epton stated that in only 5 cases out of over 400 had he found ropes to break at a much lower load than was estimated from external appearances, the estimation having been made by assuming that there was no lateral support between adjacent wires. In these cases there were excessive internal corrosion and wear, and the first-named defect would probably have been quite as pronounced in a sample cut off from the end of the rope.

A PRODUCER-GAS POWER PLANT has been installed at Rocky Ford, Colo., to operate the electric light and water-works pumping plant. There are two Weber gas-producers of the suction type and two Weber vertical three-cylinder, four-cycle engines of 100 HP. The engines are at opposite ends of a main shaft, with belt connections to a Dean triplex pump (1,000 gals. per min. at 100 lbs. pressure) and a Bullock alternating-current generator of 65 KW., 220 volts. The main engines are started with compressed air from a compressor which is driven by a 5-HP. gasoline engine. The engines are said to work on a fuel consumption of 1-lb. of Colorado anthracite coal per HP.-hour.

A PLANT FOR MAKING WHITE PORTLAND CEMENT AND USING PRODUCER GAS FOR FUEL

The new plant of the Art Portland Cement Co., at Kimmell, Ind., is notable on account of the character of its product, and also from the fact of its using producer gas as fuel in the rotary kiln. The color of Portland cement is usually of a grayish or buff tint, but this company's "Parthenon" cement is almost white in color. It is intended specially for architectural and decorative work, including the manufacture of concrete building blocks, as well as for columns, balustrades, and ornamental architectural details. It does not cause stain or discoloration. It is also claimed to have high waterproof properties, which make it especially advantageous for building blocks and exposed work. This cement is being used in the new Memorial Building at Dayton, O., and has already been used in monolithic construction for residences. It is also used (with a light-colored sand) for a veneer or finishing coat on ordinary concrete, in order to obtain a good color and to cover any marks of the forms.

The cement is made from a special selection of materials: marl (without iron), clay and gypsum. The process has been developed by Mr. Melville M. Smith, Chemist for the company, and is kept as a trade secret as to its details. It requires the material to be ground very fine, 98% passing a 100-mesh screen, and 85 to 90% passing a 200-mesh screen. The cement is said to pass all the tests required of ordinary Portland cement, and it has the following properties: initial set, 2 hrs. 15 mins.; final set, 6 hrs.; specific gravity, 3.14. The chemical analysis is given as follows: silica, 24%; oxide of iron, 0.25; oxide of alumina, 7.87; lime, 64.24; magnesia, 1.25; sulphuric anhydride, 1.32%. A 1:3 sand briquette six months old has shown a tensile strength of 640 lbs. per sq. in. The following are the average results of tensile tests for briefer periods:

	Neat cement.	1 cement, 3 sand.
24 hours	237 lbs.	...
7 days	869 lbs.	233 lbs.
28 days	1,027 lbs.	280 lbs.
2 months	1,095 lbs.	377 lbs.

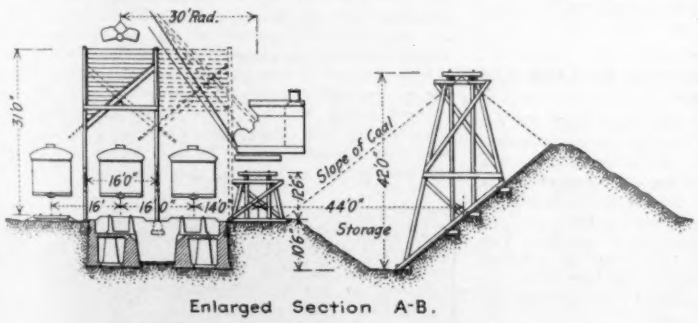
The plant has at present one kiln, and can produce about 200 bbls. of cement per day; but provision has been made for increasing the equipment and the capacity. The clay used in the manufacture is brought in by rail and handled by wheelbarrows. The marl is obtained from Sparta Lake, upon the shore of which the plant is located. A dredge boat on the lake carries a ladder dredge with a capacity of 1 cu. yd. per min., discharging into a pug mill with a stone-separator attached, and from this the marl passes to storage bins on the boat. From these bins the marl is pumped through a pipe line to bins at the mill.

The pumping is by compressed air on the Harris two-tank system. With one tank full and the other empty, but under 100 lbs. air pressure, a connecting valve is opened and the air forces the marl out through the pipe line; the compressor maintains the pressure in the emptying tank, and creates a vacuum in the other, causing the latter to fill with marl from the boat tank. This operation is repeated automatically, the tanks filling and discharging alternately. The compressor is driven by a 50-HP. electric motor. The discharge pipe is supported on pontoons, and at the dock it is connected to a pipe line about 500 ft. long leading to the marl bins or tanks in the basement of the mill. These tanks are 11 × 18 ft., 13 ft. deep, with the bottoms about 3 ft. above the water level of the lake.

In making the mixture for the cement, the marl is pumped by a centrifugal pump to a measuring tank above the mixing pan, which is a 9-ft. dry pan. Here the clay is added in proper proportions. The mixture of marl and clay then drops to a tank 10 × 23 ft., 13 ft. deep, from which it is pumped to a feeding tank over the wet mill. This is a tube mill, 5 ft. diameter and 22 ft. long, with a bevel-gear drive operated by an electric motor. The material is discharged from the mill into two slurry tanks, 13½ × 22 ft., and

13 ft. deep. The material in the various slurry tanks is kept thoroughly mixed by the constant pumping and by the return of the overflow from the tube mill. All the tanks are of concrete, made with gravel obtained at the site, and their walls form foundations for the machinery.

The fine slurry is pumped by a centrifugal pump to a closed tank, from which it is forced by compressed air to two filter presses. The press sections consist of plates with concentric corrugations draining the water, which is forced out by the air pressure and delivered to a chute beneath the press. Cloth screens over the sections retain the slurry, these being removed and washed as may be necessary. When the water has been pressed out, the air pressure is taken off, the press is opened, and the cakes of slurry are dropped into a disintegrator beneath the press. This consists of two parallel shafts having arms or blades which break up the cakes to a size suitable for feeding to the rotary kiln. There is a disintegrator under each press. The chutes above mentioned are inclined troughs of reinforced concrete running to a central receiver mounted on a swivel bearing. When the water is discharged from the press, the receiver is turned so as to deliver it to a drain. When the pressed slurry is dropped, the receiver is turned to discharge into a pivoted bucket conveyor, which carries it to the feeding hopper over the end of the rotary kiln; this is of special design on account of the sticky character of the material.



Enlarged Section A-B.

The rotary kiln is 7 ft. diameter and 100 ft. long, with a lining of Harbison-Walker blocks, 9 ins. thick for 40 ft. and 6 ins. for 60 ft. This is fired with producer gas, as already noted. Owing to the comparatively dry condition of the slurry, the character of the fuel and the length of the kiln, the kiln has a daily capacity of 200 to 225 bbls. of clinker. The clinker can be delivered by conveyors to storage bins in the yard or in the building, or delivered directly to a natural-draft rotary cooler, 4 ft. 8 ins. long and 40 ft. in diameter. The clinker then goes through an automatic weighing machine, where gypsum is added, and then to a Kent grinding mill for the first reduction. A Newaygo separator is connected to this, and returns coarse material to the mill. This separator is of a new design, having an inclined vibrating screen in a steel frame; the screen cloth is under tension and the vibration is caused by rapid and sharp blows from a number of small hammers striking its protected surface. The clinker goes finally to a dry tube-mill, 5 × 22 ft., and conveyors carry the finished product to the storage building. This is of timber construction, and has six storage bins built like the bins of grain elevators. Each bin is 14 ft. square and 20 ft. high. From these the cement is fed to packing devices in the packing room.

The gas producer and cement burner is of the Swindell type. The producer is 13 ft. 6 ins. in diameter, set with its top below the floor of the kiln room and about 15 ft. from the front of the kiln. Flues for gas and heated air lead to a chamber at the head of the kiln, where they unite and ensure a high combustion. The producer is fed with coal by sliding hoppers; when a hopper is filled it is pushed over an opening in the generating chamber, a cover removed, and the load dropped into the chamber. The air supplied for combustion in the kiln is heated by being passed through tubes formed in the walls of the chamber. Similar producers are in use at the works of the Diamond Portland Cement Co., Middle Branch, O., for firing 6 × 60-ft. dry-process rotary kilns.

The main building of the Kimmell plant, above described, is of steel frame construction, covered with cement plaster on wire reinforcement. The power-house is of concrete blocks. All the machinery is operated by individual electric motors. Mr. Geo. W. Miles is President and Mr. Melville M. Smith, General Manager and Chemist of the Art Portland Cement Co.

THE SOUTHERN RAILWAY'S FREIGHT YARDS AT ATLANTA, GEORGIA.

For the last few years the Southern Railway has been annually extending and improving its yards at Atlanta, Ga., to take care of its rapidly increasing freight business. This development finally reached its limit last year and it was decided to select a new location for a yard where there would be ample room for both present needs and future growth. After much consideration Mr. C. H. Ackert, Vice-President and General Manager, decided on the location of this new yard at Inman, lying north of the Marietta road, on the main line between Atlanta and Chattanooga and Birmingham, this site being convenient to serve the various main lines of the Southern entering Atlanta and also within a reasonable distance of the various connections of the road.

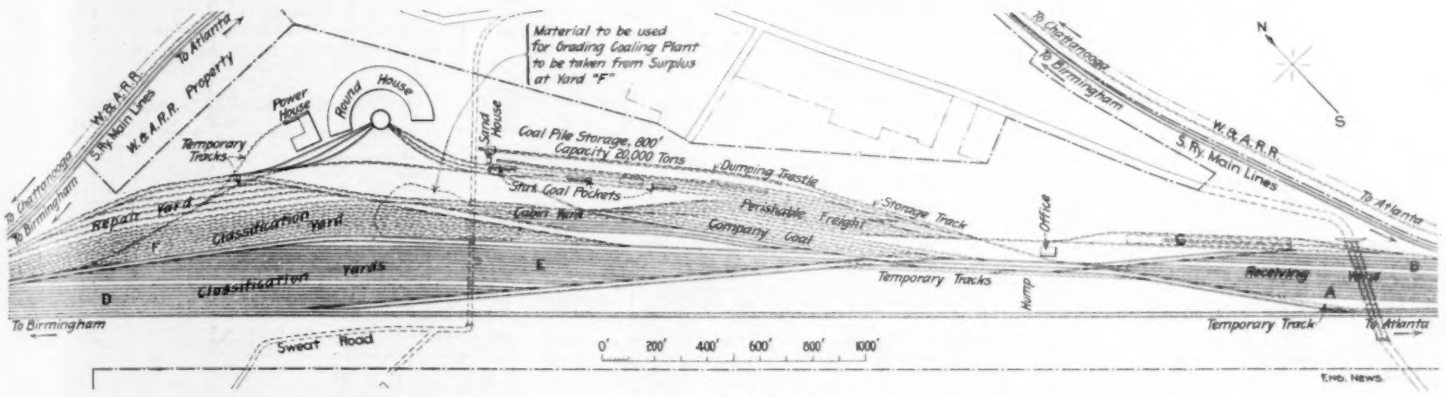
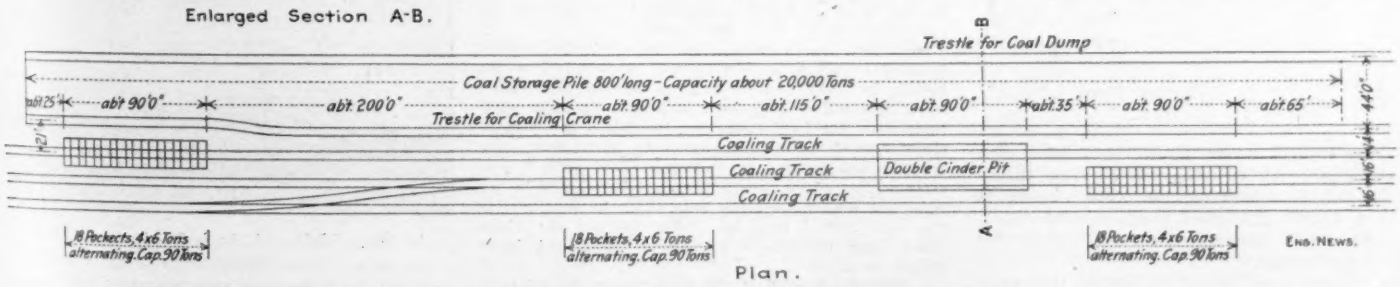


FIG. 1. GENERAL LAYOUT OF NEW FREIGHT YARDS OF SOUTHERN RY., NEAR ATLANTA, GA.

The old line at this point has a nearly uniform grade of about 33 ft. per mile, descending to the Chattahoochee River, the alinement being a succession of sharp curves. The new plan provides for abandoning the old line and building a double track of very much better alinement, involving heavy cuts and fills, much of the excavation being through solid granite.

It was desired to build a double hump yard which should serve all the Southern Railway lines entering the city, embracing the Chattanooga and Birmingham roads, from the northwest and west, the Macon road from the southeast and the Columbus road from the south, and providing for the Charlotte main line northeast. On account of the contour of the country, and the grades descending toward Chattahoochee River, it was found not practicable to so arrange the yard, but in its place a one hump yard arrangement was substituted, which while requiring a certain amount of back movement for trains working in one direction, would very well serve the purpose with a minimum amount of switching.

Fig. 1 indicates the arrangement of the yard, which, as will be observed, permits trains routed



Plan.

FIG. 2. PLAN AND SECTION OF COALING STATION.

for Chattanooga and Birmingham to enter the receiving yard at the south end, pass over the hump and be classified in their proper direction. Trains from Chattanooga and Birmingham, bound for Atlanta, Charlotte or Macon, will leave the main line at the northwest end of the yard, pass between the classification yard and the

main track, alongside of the hump, and enter the receiving yard on the side nearest the main line, and from that point be dropped back over the hump to their proper tracks, and when made up will enter the main line, proceeding on their proper course.

The grade of the receiving yard is about 0.65%, descending toward the hump, but rising before reaching it in order to allow uncoupling; the ladder below the hump has a grade of 1%, which diminishes to 0.4% through the classification yard, joining the main line at the lower end, the main line being practically of a uniform grade.

In connection with the yard there has been built a 30-stall roundhouse, a small machine shop, a pumping station with accompanying electric power plant and a coaling station with cinder pit.

There is consumed at this point about 200,000 gals. of water daily, and to supply this the pumping plant and water tank have been built to take water from the Chattahoochee River. The station is supplied with two 9 × 10-in. vertical triplex, single-acting Worthington pumps. These

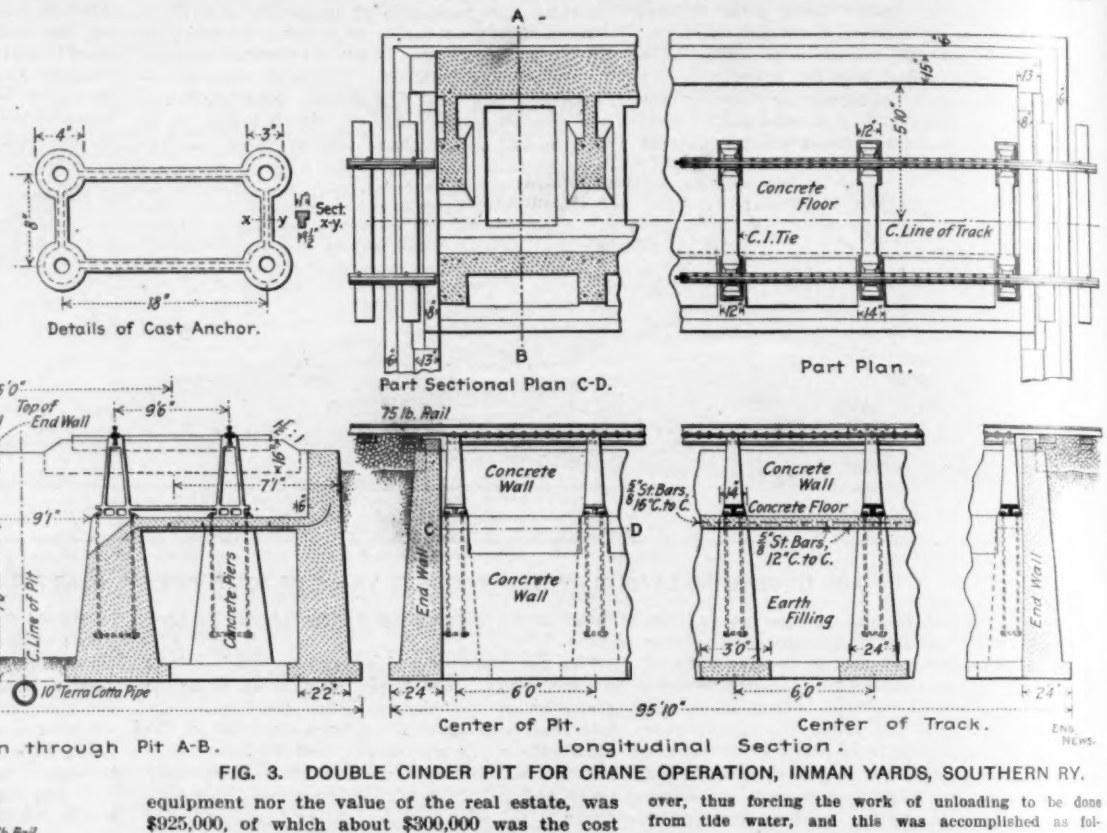
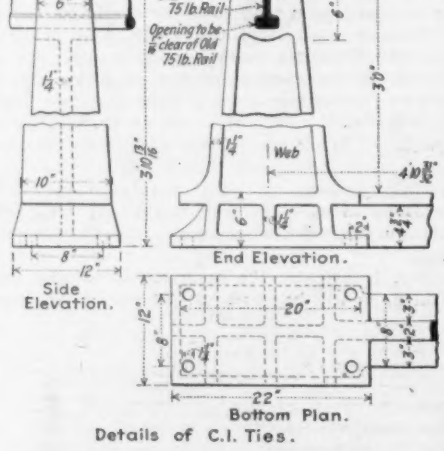


FIG. 3. DOUBLE CINDER PIT FOR CRANE OPERATION, INMAN YARDS, SOUTHERN RY.



Details of C.I. Ties.

are driven from a power plant three miles distant, equipped with two General Electric three-phase 50-HP. induction motors. The storage is kept in a 100,000-gal. steel tank, erected 40 ft. above the roundhouse and with its bottom 100 ft. above the tracks.

Special care was taken to make the general construction and detailed designs of the coaling station (Figs. 2-3) conform with the latest and best practice. The coal is dropped into a pit with a storage capacity of about 20,000 tons, or about 25 tons per lin. ft. This pit is filled from a trestle reached by the ordinary incline approach. Parallel to the coal pile is another light trestle upon which is operated a locomotive coaling crane, which takes the coal directly from the pit and places it in the tenders. There are also coal pockets of 300-ton capacity, which will be kept filled and used for coaling engines when the crane is otherwise employed. The cinder pit is of all steel and concrete construction so as to preclude all danger of destruction by fire. It can be cleaned by the same locomotive crane that serves the coal station.

Two or three important streets or roads crossing the site of the yard were spanned by old railroad bridges taken from other points along the line. Concrete piers and abutments were employed for these bridges.

The cost of improvements, not including equipment nor the value of the real estate, was $925,000, of which about $300,000 was the cost of grading the site. This grading consisted of about 733,000 cu. yds. earth excavation, 107,000 cu. yds. loose rock and 82,000 cu. yds. solid rock, for yard proper and 252,000 cu. yds. for double track and the Peyton cut-off.

MOVING A 30,000-BARREL OIL TANK BY LAND AND WATER.*

A unique problem in engineering confronted the gas department of the California Gas & Electric Corporation a few months since, when it was desired to move a 29,500-bbl. iron oil tank from the old gas plant of the San Francisco Gas & Electric Co., at North Beach, to the plant of the Oakland Gas Light & Heat Co., on the Oakland estuary. Many plans were considered and abandoned, such as cutting it in sections in different ways, etc.; but the cheapest method by half, with the manner in which it was finally solved and the work accomplished, is set forth [as follows]:

The tank has a wooden cover, which is securely fastened to the upper sheets, and supported from the bottom by forty 6 × 6 uprights, serving to make it more rigid and able to resist buckling. To begin with, holes were dug in the masonry foundation in about 20 places around the tank to receive the jacks; then, very carefully and evenly, the tank was raised until it was up to a point where more timbers and jacks could be got under the bottom, and the sag, which to our surprise was only from 4 to 5 ins., taken out and the whole raised high enough to get the cribbing and large timbers in place.

It was then handled in the same manner as a house, taken about a mile through the streets, around one corner, and to the water's edge; and it is interesting to note that at one point, where it was taking up not only all the street but all the sidewalk as well, the tank cleared the houses on either side by only about 3 ins., and covered their porches completely.

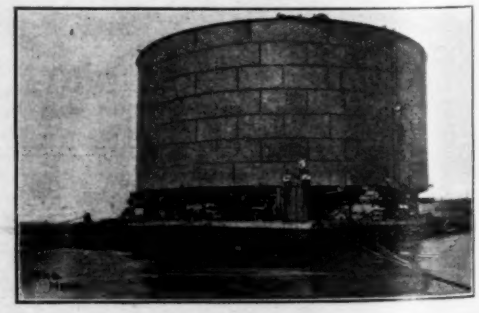
When all was ready in Oakland, two large barges, about 100 ft. long, were lashed together and the tank run aboard at high tide on June 30, 1907, as shown in [the accompanying view], the actual time for the work being 1 h. 20 min.

The next day proving to be free from wind, the voyage across the bay was commenced at 9.15 a. m., in tow of a steam tug, while another tug stayed alongside to render assistance in case of need. By 1 p. m. the 10-mile journey across the bay and up the channel was finished, and the barges tied to the bulkhead ready to be unloaded.

The original plan of unloading was to bring the barges up to the bulkhead opposite the foundation at high water and sink them. It was found necessary, however, to dredge this place before the tank could be brought over, thus forcing the work of unloading to be done from tide water, and this was accomplished as follows:

Two double rows, of 3 piles each, were driven between the bulkhead and deep water, about 40 ft. apart, capped and cross-timbered; and at high tide again, all being in readiness and the barges securely lashed to the piles, the big tank was started on the rollers, and in 45 minutes was resting securely again on land.

After being run into position on its new foundation, the reverse operation used in lifting was begun; it was lowered evenly, the last timbers were taken out when a little over 1 ft. from the foundation, and supported only from the outer rim by 20 jacks set in holes left for the purpose in the edge of the foundation. When all



An 80 x 33-ft. Oil Tank Ready for a 10-Mile Water Trip.

were out the jacks supporting [the tank] were lowered and the job was completed. Before lowering the bottom was carefully coated with tar paint to protect it against moisture, as was also the top of the foundation.

The tank is 80 ft. 1 in. in diameter by 33 ft. high, and holds 1,239,189 gals. The weight is approximately 172,000 lbs., or 86 tons, and although everything went without a hitch, and not a thing happened to cause the least concern, the tank being perfectly tight when tested, everyone breathed a sigh of relief when it left its unnatural element and was again on terra firma.

*A paper prepared for the Fifteenth Meeting of the Pacific Gas Association. Our slightly condensed text is based on a reprint found in the "American Gas Light Journal" for Sept. 30, 1907, from which we have also reproduced one of four half-tones there given.—Ed.

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The use of twin screws on ocean passenger steamers has become so common within the past dozen years that it has perhaps been forgotten how important this improvement is as a measure of safety. A remarkable illustration of its importance was furnished last week, when the North German Lloyd liner "Kaiser Wilhelm der Grosse," one of the largest and fastest vessels afloat, reached Plymouth, England, at the end of a transatlantic voyage of which the last 1,700 miles were made without a rudder.

Either the sailing vessel or the single-screw steam vessel has always been at the mercy of the winds and waves—to use the trite phrase—when its rudder was disabled. With vessels of ordinary size it has been possible to rig some sort of "jury" rudder, and in that way govern the course of the vessel sufficiently to enable her to follow her course. With the modern large-size ocean passenger steamers, however, the rigging of any sort of jury rudder is almost impossible, and the advantage of twin screws, enabling a vessel to get along very comfortably without a rudder, is illustrated by this accident to the big German steamer.

A curious story went the rounds of the New York newspapers last week, reflecting rather seriously on the reliability of engineers. The statement as published was to the effect that, through a blunder in the calculations of the locating engineers, a long stretch of embankment on the new line of the Pennsylvania R. R., across the Hackensack Meadows, had been built about 200 ft. out of place. It was alleged that the entire work would have to be done over again, that the embankment already built was useless, and that the company was likely to lose several hundred thousand dollars through a blunder in the calculations of the locating engineers. The story seemed absurd on its face, but we thought well to investigate it, and applied for information to Mr. Samuel Rea, M. Am. Soc. C. E., Third Vice-President of the Pennsylvania R. R.

From the information furnished by him, it appears that there was no mistake whatever by the locating engineers. The reporters saw a new stretch of embankment being built in a different position from the old one, and based their story upon it. The actual fact was that at the time the first-named embankment was built, it was intended to change from steam to electric locomotives at the portal of the tunnel underneath the Palisades. Recently it was decided to extend the run of the electric locomotives to Harrison, on the outskirts of Newark, four miles farther west, and use the yard facilities there for the change of locomotives. This change made advisable a change in alinement of the track near the tunnel portal, where trains will naturally run at much higher speed than was originally expected; and it was this new embankment, built to provide improved alinement that gave rise to the reporters' story.

The notes on the water-works of Japan, included in Mr. Johnson's article on "Oriental Water-Works," elsewhere in this issue, give a fairly comprehensive idea, as we understand it, of all the municipal water-works of Japan. If anything progressive pertaining to that remarkable country any longer surprises a well-informed person it will be that filtered water is supplied to practically all the Japanese people who have the benefit of municipal water-works. Other notable features of Japanese water-works are the percentage of taps metered and the liberal provision of fire hydrants. Particular attention may be drawn to the attractiveness of the Osaka water-works laboratory and its surroundings. Besides the description of Japanese works, the article in question contains interesting notes on other Eastern water-works, but for obvious reasons a complete water-works survey of more than one country is impracticable in such an article.

Engineers have been awaiting with much interest a final report from the committee of the American Railway Association which has been at work for several months on standards for steel rails. The regular fall meeting of the Association was held in New York last week, but the committee was able to present no unanimous report, the representatives of the manufacturers and of the railways having been unable to reach an agreement. Majority and minority reports were presented but have not been made public, and the whole matter was referred back to the committee for further consideration. It is generally understood that the committee succeeded in reaching an agreement on some new types of rail sections which will have the metal more equally distributed between the base and the head, and will be stiffer than the present American Society of Civil Engineers' sections. Doubtless these new sections are designed with a view to the use of tie-plates, which permit a narrower base than was possible 20 years ago, when the American Society of Civil Engineers' sections were designed, at which time tie-plates were little used.

Another and very important advantage of the new sections is that the rail is expected to cool with less bowing out of line and consequent less maltreatment in straightening. The thicker web and foot, moreover, will permit the rail to be rolled at lower temperature, which should improve the quality of the metal.

With regard to the specifications for composition, however, the steel-rail makers, we understand, were unwilling to agree to the demands of the railway engineers. The latter desire to lower the limit of phosphorus below the present standard of 0.10, but the manufacturers claim that the dwindling supplies of Bessemer ore, and the fact that a large percentage of that which comes to the furnaces is close to the present phosphorus limit, make it impossible to supply Bessemer rails with lower phosphorus than the present standard. It is altogether probable that the near future may see an extensive use of basic open-hearth metal for rails, in which case there will be no difficulty in furnishing a low-phosphorus metal.

The second point of disagreement is as to the percentage of the top of the ingot which should be discarded. Manufacturers strongly oppose a rigid requirement that any considerable percentage of the ingot must be cut off. They claim, with much apparent reason, that the extent of piping and segregation varies very greatly with the conditions under which the ingot is made, so that a fixed percentage of discard would lead to large waste in many cases, and in others would be insufficient to guarantee sound metal.

One of the stock arguments commonly used in setting forth the advantages of railway over water transportation has been the greater speed of the railway train. While it is true that special classes of freight can be, and often are, handled with remarkable despatch by main line railways, it is unfortunately the case that ordinary freight, which has to take its course and be transshipped at various junction points, is likely to experience long delays. We find an interesting example of this reported in the English "Society of Arts Journal" for Oct. 11. An English company, dealing in cotton, making its purchases in the United States and selling to British spinners, bought 5,000 bales of cotton in Memphis last season, and on account of the congestion of freight traffic they were stored in Memphis for three months before they were even started on their journey. The result was not only long delay, which, from changes in the markets might have caused very serious loss, but great injury to the cotton itself from exposure to the weather. To guard against future losses of this sort, the company has built its own compress at Memphis and will ship by barges direct to New Orleans, four days being required for the trip. The cotton will be transferred from the barge directly to the ocean steamer without being landed on the wharf at all.

There is no doubt that in the matter of handling in terminals water transportation lines have often many advantages over rail lines, and no small part of the present agitation for government water-way improvement is to be traced to the long delays in the handling of freight shipped by rail.

A campaign against water pollution is now being conducted with varying degrees of energy and wisdom in a number of states of the Union. Of particular interest and suggestiveness are the methods being employed by the New York State Department of Health. These methods are indicated in an article published elsewhere in this issue containing abstracts of reports on water pollution in the Oswego and Upper Hudson drainage areas. It need only be said here that the general method followed is to make a comprehensive study of the nature, volume and uses of waters in question and also of the nature and volume of the matters polluting them, all to the end that the Department may wisely use its powers to regulate pollution. These powers are limited to sewer outlets and to sewerage extensions constructed since 1903, when the Department was given enlarged control of stream pollution.

The Oswego investigation and report was immediately followed by communications to the authorities of the various municipalities, outlining the future policy of the Department regarding stream pollution in the Oswego drainage area. This policy is that hereafter no person, corporation nor municipality will be permitted to discharge sewage [from a new outlet] into the Oswego River, its main tributaries nor the lakes in the drainage area unless it has been given a "preliminary treatment." The treatment required will vary with local conditions and may change from time to time, but in general it will fall into two classes: (1) Where the sewage is to go into lakes *not used as public water supplies* it must be so treated as to remove "all solid and suspended matter" and to prevent "odors or other offense" "in the vicinity of the points of discharge." (2) Sewage going into the Oswego River, into such of its main branches as are outlets to lakes, *and into lakes used for public water supply*, must previously be subjected to a "complete process of purification," which shall give an effluent always free from suspended matter, and also free from "any dissolved or other organic matter that may undergo subsequent putrefaction."

The methods of the Oswego River investigation and the spirit of the subsequent warning as to

further pollution deserve commendation. The investigation seems to have been well suited to determine the present and probable future condition of the waters involved, as regards pollution, and the warning, with its broad outline of preventive measures, gives promise of discrimination in applying the remedies to specific cases, as they arise, instead of laying down arbitrary rules, applicable to all cases, in advance. Moreover, it is to be noted that even where public water supplies are involved no bacterial standard of sewage purification is set up; but it should be noted that the warning indicates the possibility of more stringent requirements if demanded by individual cases of pollution.

We hope to see water pollution in other drainage areas, both within and without New York State, handled in an equally satisfactory manner, and that speedily. A careful study like this, followed by rules fitted to local conditions, as found, is worth a thousand broadsides insisting that the discharge of sewage into streams must stop, utterly regardless of the volume of the sewage, the volume and uses of the streams, and the sanitary needs of the communities involved.

SOME WEAKNESSES IN THE ORGANIZATION OF MUNICIPAL ENGINEERING AND PUBLIC WORKS DEPARTMENTS.

Engineers in the municipal service lack the opportunity to do their best for the city and for themselves that would be afforded them if there were not so many defects in the organization of municipal engineering and public works departments in the United States. These departments to-day are organized on too narrow a basis and frequently they are altogether too much split up into independent branches to meet the needs of their cities as a whole. Unification, or at least correlation, is greatly needed. This unfortunate condition is largely due to the lack of public confidence in city councils and the consequent entrusting of important public works, involving large expenditures for construction and operation, to boards and commissions. Each of these boards is generally entirely unrelated to every other similar board in the city, and not infrequently each is quite independent of any other branch of the city government. The result is that each board has its own engineer and conceives and executes its work with very little consideration for any other of the needs of the city. Thus, instead of a carefully planned municipal program,* there are as many separate and conflicting programs as there are departments.

Perhaps New York City is one of the most notable examples of lack of co-ordination in its engineering and public works departments that could be cited. It seems strange indeed that the second largest city in the world should be almost the only municipality of any size without a City Engineer or a centralized Department of Public Works. The recent appointment of a charter revision committee has led the Merchants' Association of New York City, through its Board of Directors, to make some interesting and valuable suggestions for amendments to the city charter, which suggestions we seize upon to change our further discussion from the abstract to the concrete.

The first of these suggestions that we shall note urges the creation of a Department of Street Control for New York City. This department would have sole jurisdiction over nearly everything pertaining to street construction and operation, and a large measure of control over certain of the ways in which the streets are used by public service corporations. In place of the present independent bureaus of highways, sewers, street cleaning and street encumbrances, the proposed department of street control would have sole jurisdiction over street grading, paving, maintenance, cleaning and lighting; over sidewalks, vaults beneath them, and awnings, show-cases and other encroachments above or upon them; also over the construction and maintenance of sewers; and last, but by no means least, over the operations in the streets of gas, electric lighting, telephone, steam and other public service corporations. The department would be given specific control of the making and restoration of all openings in pavements or sidewalks, "including pavement removed by the Department of Water Supply." This department, it may be added, is the only one that would be left of those having to do with important street construction, that was not merged in the new and comprehensive department of street control. The present Department of Water Supply has included in its title and jurisdiction Gas and Electricity, which would be taken away from it by the proposed change.

It is hardly necessary for us to state that such a consolidation of departments as is proposed would have many advantages, particularly as the directors of the Merchants' Association make the further proposal that the presidents of the five boroughs composing New York City be divested of their present control of highways, sewers and street encumbrances. Whether or not it is advisable to curtail the powers of the borough presidents in this way, is a local question that we do not propose to discuss here, further than to say that there would be very great and obvious advantages if some of the main sewers and the general scheme of sewage disposal, and also some features, at least, of street improvements, were controlled by a central body instead of the officers of five local divisions.

Another suggestion made by the Merchants' Association contains so much of great importance bearing upon our general subject that we quote the paragraphs setting it forth, as follows:

> One of the most important of these is that a special commission be appointed to analyze the functions of every branch of the City Government, and formulate a proper system of accounting and statistical record for each, in order that the annual outlays of each may be effectively scrutinized and the annual requisitions presented in such form that the Board of Estimate and Apportionment can act thereon with full knowledge. The Association contends that at present the City's budget is largely voted upon requisitions in bulk without adequate exhibits of expenditures in detail, and without the statistical records necessary to intelligent judgment upon the proposed outlays. In consequence many of the appropriations for various purposes are largely in excess of the amounts actually needed, and cover great waste.
>
> The Association believes that such a commission should be composed principally of business men with large experience in directing the accounting, reporting and auditing of large business enterprises with a view to economical administration by means of concrete and readily understandable reports in such form as to fully exhibit all transactions; and that the Comptroller should be ex-officio a member. The Commission should have at its command an adequate force of expert accountants, engineers and clerical assistants.

We have often discussed the need of sweeping reforms in municipal accounts and records, and heartily endorse the general proposal made in the above-quoted paragraphs. Every city engineering department in the land is hampered (though all too few realize it) by the lack of an accounting and statistical system that would enable those responsible to know accurately and from year to year what the works constructed and operated by them really cost, both in original outlay and also in yearly capital charges and operating expenses. We will not dilate upon this point at present.*

We wish to say a few words in conclusion about one phase of the subject of municipal budgets, discussed above by the Merchants' Association, which the directors of that body either have overlooked or else, for the sake of brevity, have not mentioned. Important as is the proposition to have a special commission analyze the functions of each branch of the city government and formulate a system of accounts and records, it should be realized that the analysis of city functions, and particularly of city needs, should continue from year to year in order to meet changing conditions in both functions and needs. A large part of this very necessary analysis can best be made by the department engineers of the city, and it will be best made, and the needs of the city as a whole will be best considered, if there is a proper centralization of the city engineering departments. Just how such a centralization could best be effected, either in New York City or elsewhere, we do not attempt to say. But we do wish to urge upon the attention of all engineers and city officials the need of a considerable degree of centralization, or, as we have previously said, at least of correlation, of municipal engineering and public work departments. Whether a city engineer or a central engineering department composed of a chief engineer and engineers of bureaus is more desirable is a question that can best be settled by each city for itself. In some cities, political or other considerations may seem to make it necessary to provide for a commissioner or department of public works, with the engineering force occupying a secondary position. This may or may not give due recognition to the engineer and his work, but with a proper correlation of the several branches of the engineering work of the city, great advantages would accrue both to municipal engineers and to the general public, even though the engineering officials were made quite secondary to commissioners of public works, whether the latter were appointed for political reasons or in accordance with what seemed to be the best plan of organizing city business. In any case, the position of the municipal engineer would increase in dignity and importance, and some great weaknesses in municipal engineering work would be eliminated.

*For a brief editorial discussion, entitled "A Municipal Program Essential to Symmetrical and Continuous City Development," see Eng. News, July 17, 1902.

*Those interested can find this general subject discussed at some length in Engineering News of June 14, 1900, under the title "Uniform Accounting a Prerequisite to National Municipal Statistics."

LETTERS TO THE EDITOR.

A Bridge Engineer Prodigy.

Sir: A consulting engineer from the East has been examining some old bridges in this city and I enclose a newspaper clipping showing our City Engineer's opinion of the said Consultant's ability—or at least the reporter's report of what the City Engineer said:

> I never saw such ability as the professor showed. He would look at a plan offhand and could immediately tell without figuring what the strength and possible life of each member of the bridge would be.
>
> It certainly is wonderful to be able to use the divining rod in the bridge business! B. C. J.

Oct. 21, 1907.

Sunfish and Typhoid Fever.

Sir: I enclose herewith clipping from the Kansas City "Star" which I think you will find of interest. It would certainly seem as though the fish which by preference feed upon the typhoid fever bacillus must have eyes of microscopic power.

Very truly yours,
Charles W. Sherman.

14 Beacon St., Boston, Mass., Oct. 31, 1907.

[The press dispatch in question is as follows:

> Pittsburg, Oct. 12.—To prevent a typhoid fever epidemic visiting Pittsburg next summer, as has been the case the last two summers, the city has imported 700 sunfish, which Dr. Edwards of the bureau of health expects to do the work.
>
> The fish arrived to-day and are being placed in the streams in the parks, while a large number of them will be placed in the reservoirs. Another consignment is expected soon. These will be liberated in the Allegheny River near the pumping station at Brilliant.
>
> Dr. Edwards says if there is anything a sunfish likes it is a typhoid fever germ. For that reason the fish are expected to thrive in the streams hereabout. It is also said the sunfish is sure death to malaria germs and that they really are desirable citizens in every way. A heavy fine will be imposed on any one who catches the sunfish.

We apologize to Dr. Edwards for reprinting a story that, taken seriously, does him so much injustice, but of course our readers will understand that the story is either a newspaper hoax or else a confusion of facts.—Ed.]

The Proper Load for a South American Burro.

Sir: On p. 204 of "Railroad Location, Surveys, and Estimates," by F. Lavis, I note that bundles of 150 lbs. are advocated for use in South American countries, two of which will make a burro load.

The usual practice in this country is as follows: A mule load is from 200 to 300 lbs. A burro load, from 125 to 150 lbs. A llama load, from 50 to 75 lbs. On some of the trails where transportation is exceedingly difficult a mule load is 100 lbs. only; and all loads are made up in 25-lb. packages.

Mr. Lavis' burro is a remarkably strong animal.

Yours truly,
Wm. T. Gibson.

Chief Assistant Engineer, Location, Bolivia Ry. Co.

La Paz, Bolivia, Sept. 19, 1907.

[Proof of the foregoing letter was submitted to Mr. Lavis, and we print his reply below.—Ed.]

Sir: I thank you for the opportunity to reply to Mr. Gibson's letter calling attention to an obvious error in my "Railroad Location, Surveys and Estimates." The weight of packages for burros should, of course, be 50 lbs. instead of 150, and this has been corrected in the second edition which is now in press. This would have been detected by an engineer with much experience on reading further; on page 211 it is stated that "300 lbs. is a fair load for a pack animal." The word "animal" in this connection is generally understood to mean a mule or a horse. However, as the book was meant to be a guide for the inexperienced as well as the experienced locators, the criticism is a fair one.

Yours very truly.

F. Lavis, M. Am. Soc. C. E.

42 South Tenth Ave., Mt. Vernon, N. Y., Oct. 30, 1907.

Column Strength and the Quebec Bridge Failure.

Sir: While I share in the admiration expressed by a large number of the readers of Engineering News for the masterly presentation of your first study in the failure of the Quebec Bridge, I must dissent from your repeated assertions or implications to the effect that the weakness in the compression chords, supposed to have failed first, is shrouded in mystery or attributable to some unknown principle in column strength. Your editorial in the last issue (Oct. 24) in particular calls forth this protest. From it I quote the following: "Let them search their treatises or text books or the discussions before their technical societies; they will find nothing to warrant them, for example, in condemning the compression chords which buckled in the fall of the Quebec Bridge, or asserting that this or that design for similar members were better." I cannot indorse this statement; for, to the contrary, I find the very fundamental principle of column design was violated in these compression chords. It was evidently done unconsciously—negligently. In this statement I do not wish to criticise unjustly the designers of this great structure. Many of us might have fallen into the same error.

All formulas for column strength contain the factor r, the *least* radius of gyration. In designing columns with two or more parallel webs, it is customary to place the webs at such distances apart that the moment of inertia about an axis parallel with the webs is equal to, or generally a little greater than, that about an axis perpendicular to them, assuming that the lattice-bars, tie-plates, cover-plates, or whatever are used to bind together the integral parts, are sufficient to make the member act as a unit. The radius of gyration about an axis perpendicular to the webs is then used in the column formula, and is in reality the least radius.

But a simple calculation on the chord A 9 (assuming the sketch in your issue of Sept. 19 to be correct) shows that the greatest moment of resistance to bending which can be developed about an axis parallel to the webs is only about $^1/_3$ that which can be developed about an axis perpendicular to them; yet the radius of gyration corresponding to the latter was evidently used in the calculation, or, in other words, a radius of about 16 was used, making $l/r = 43$, hence no reduction was made in the working unit, whereas the actual least radius probably did not exceed 10, making $l/r = 68$. This condition was due not to the improper spacing of the webs but to the inefficient method of binding them together.

This is not the only defect in the design of these chords. Others have been pointed out by correspondents in your columns. But it is enough to show conclusively that we have something to warrant us in condemning them.

Respectfully yours,

Chicago, Ill., Oct. 28, 1907. W. C. Armstrong.

[Presumably this refers to the fact that the latticing, acting as web-system of the girder when the member is considered to resist bending by lateral forces, is not strong enough to carry the load required to develop the theoretical bending resistance of the cross-section; and that therefore a reduced value of the radius of gyration should be assumed in calculating the column length-ratio. This is practically the same argument as was advanced in another correspondent's letter on "Column Strength and the Quebec Bridge Failure" printed in our issue of Sept. 26. The flaw in this argument lies in the assumption that lateral strength and lateral stiffness are measured by the same quantities. In column calculations the lateral stiffness alone is involved, and it makes no difference whether or not the lateral web-system is strong enough to stress the flanges to their point of failure. Therefore, as long as a complete web-system is present, the full radius of gyration of the cross-section around its gravity axis must be used in determining the length-ratio. There is, of course, a slight effect realized from the web-system, namely the reduction in stiffness (or increase of deflection) chargeable to the elastic deformations of the web-system. But this effect, which is not constant for a given member but depends on the distribution of shear in the web, or on the relation between shear and moment (which in turn depends on the nature and distribution of the loading), is small and difficult to calculate. It is evidently not the effect referred to in the above letter.—Ed.]

The Quebec Bridge: Why was the Span Increased? The Forth Bridge Type Again Advocated.

Sir: A careful reading of the excessively interesting articles and letters on the subject of the Quebec bridge disaster which have appeared in your columns, and in which the exceptional magnitude of the bridge has been—erroneously, I think, the center span being treated as the bridge—particularly dwelt on, leads me to put a question which first occurred to me in 1904, when, in company with many other engineers, as the guests of the Canadian Society of Civil Engineers, I visited the bridge. The main piers were then erected, and they were standing just at the water's edge, evidently in very little depth of water. The question arose why were they not built closer together, with a shorter span adopted. No cross-section of the river, which might have afforded an answer, was then available to me.

But such a cross-section is now to hand in the diagram Fig. 1 on page 258 in your number of Sept. 5, 1907, and it leaves the question still unanswered. The bed of the river is shown sloping both on the north and south banks very gently indeed, for a distance of over 100 ft., so gently in fact that approximate scale dimensions show that either pier might have been moved in towards the center of the river a distance of 75 ft. if not 100 ft., without an additional depth of water of more than 10 ft. being met with. What was there to prevent this shortening of the span by, say, 150 ft. at least? So far as superstructure is concerned, there can be no doubt that an enormous saving in expense could have been made, or greater strength and stiffness could have been provided. As to foundation of piers, I have no information what they are on, but from the dip of the rock—if it is intended for rock—shown at the south anchor pier, it does not appear that the foundations of the existing main piers are on it, and if so, those of piers say 75 ft. further away would be on no worse material and would be subject to the objection only of the slightly additional depth above referred to.

So much has been said about the size of the Quebec Bridge, and so much satisfaction has been shown because the favorite superlative qualification "the biggest in the world" can be claimed for its center span, that, in the absence of any other apparent reasons, one is tempted to inquire whether the predominant consideration in fixing the span at 1,800 ft. was not that the largest bridge span existing at the time the bridge was designed, that of the two main spans of the Forth bridge, was 1,710 ft. and that it was desirable to "go one better" and obtain this satisfaction attaching in the minds of some to the possession of the biggest thing of its kind. Engineers certainly will look for some better justification than this for the adoption of the excessively large span of 1,800 ft.

Parenthetically I may say that it cannot correctly be said that the bridge was to be of "unprecedented size" and that "the structure surpassed in size any bridge ever erected." The Forth bridge may possibly be exceeded in respect of total length or perhaps in some other particulars by some of the bridges in the United States or in India,—I have no details available—but certainly the two main spans alone of the Forth Bridge exceeded in length the total span of the Quebec bridge. The latter, it is true, was to carry roadways and footpaths in addition to a double line of railway, but it appears from your article of the 12th of September that the live load on the latter was considered so insignificant that it was not reckoned in the live load on the trusses, so that the extra accommodation afforded by the bridge does not, from an engineering point of view, count for very much.

The increasing expression of approval of the circular form for large columns has brought forth a protest in your columns of the 3d inst., in advocacy of flat plate construction, and other practice universally adopted in America, and, be it added, generally so in Europe; and this in face of the admission that a flat plate is inherently weak to resist compression as compared with the same plate bent into the form of a circle. The reason given for this championship of the flat plate—that the whole system of bridge construction in the Western world is based upon the use of such plates—strikes one as peculiar. The last place that one looks for hidebound and traditional ideas and practice is on the Western side of the Atlantic, and if the size of a bridge and of its component members become so large that the practical disadvantages of the circular column when in small sizes are overcome and exceeded by its theoretical and practical advantages in the special structure, I think that the American or Canadian Engineer will be the first to recognize the propriety of adopting this form without being hindered by considerations of customary practice.

The Quebec bridge will of course be carried to completion and probably by the Dominion Government now, as it is an integral part of the new Transcontinental Railway to which the Government is committed. It would be idle to speculate what lines will be followed in the design for the new structure, but in view of the object lessons afforded by the disaster of the 29th of August, and the success of the Scottish bridge one might indulge in the fancy of a shortened span giving an opportunity for the double main piers of that bridge, with their accompanying stiffness. And perhaps, too, we may see that the circular strut has claimed its recognition and has justified and secured its adoption. I am,

Yours truly,

John D'Aeth, M. Inst. C. E.

Halifax, N. S., Oct. 25, 1907. (Kingston, Jamaica.)

[There is fallacy in the idea that by changing the span of the Quebec Bridge from 1,600 ft. to 1,800 ft. we pass suddenly from the region of the conservative and safe to a region of wild uncertainty and insecurity. Equally remarkable is the idea that by shortening the span from 1,800 to 1,650, or even 1,500 ft., the task of construction is changed from the difficult and dangerous to the relatively easy. Surely, there is no such sudden transition in engineering achievements involved.

We should hesitate, even in the absence of more specific information, to attribute the increase in length of span of the Quebec Bridge from 1,600 to 1,800 ft. to any feeling of vanity, or desire to outdo some other structure. No reputable engineer, so far as we know, solves his problems on such a basis, and we are surprised to see a motive of this kind attributed in the present case.

The recommendation for the change in length of span was originally made by Mr. Cooper, we understand. The competition for plans called by the Quebec Bridge Co. was on the basis of a river span of 1,600 ft., and the change was made after the prizes had been awarded and the contract virtually (if not actually) let. During an interview which a representative of Engineering News had with Mr. Cooper just after the fall of the bridge, the change of span was incidentally mentioned, and Mr. Cooper explained it in very simple manner. The piers for the 1,600-ft. span would be very difficult to build in a single season, and because of the severe winter and great danger from ice at Quebec, and the high tidal range, it seemed necessary to finish the work in one season. With the larger span, bringing the piers into much shallower water, this could be accomplished much more easily.

Besides this, when the entire work was finished, it was desirable, we believe, to have the completed piers as far removed as possible from the force of the huge masses of ice borne up and down the St. Lawrence channel by the rapid current due to a tidal fall of over 20 ft. Of course the deeper the water in which the piers stand, the higher above the foundation will this enormous ice pressure be exerted. From this point of view the increase of span of the Quebec bridge impresses us as a conservative measure eminently desirable to guard the safety of the structure.

We are not informed how the saving in substructure due to the piers being in a less depth of water compared with the increased cost of superstructure in the 1,800-ft. span, but this we believe to have been unimportant at best, compared with the matter of safety.

In the matter of the circular or cylindrical form for bridge members, it is only necessary to refer to the general practice of bridge construction, which does not look with sufficient favor on the circular form to adopt it anywhere. There is precisely as good reason for using cylindrical members in a truss bridge of 300-ft. span as for using such members in a bridge of the dimensions of the Quebec bridge. Yet such members are not used in 300-ft. trusses, and, we believe, will not be used in 1,800-ft. bridge spans. The difficulties of carrying the stresses into and out of a large circular member at the joints are alone sufficient in our view, to outweigh any possible gain in the

member itself, even were such gain a demonstrated fact, which it is not. The towers of the Manhattan bridge over the East River at New York City, far larger than any compression members of the Quebec or Forth bridges, are made up of plates and angles in rectangular arrangement.

The incidental advocacy, in the above letter, of the plan of using two main piers carrying a braced tower, in place of the single pier carrying a post bent, involves a fallacy hardly worth while entering into in this place. Indeed, the proposal has no more in its favor than a proposal to provide each end of a simple truss bridge with two pairs of pedestals, one at the end and the other at the first panel-point.—Ed.]

Traffic on Fifth and First Avenues, New York City.

Sir: During the examination made by the Commissioners of Accounts of New York City of the administration of the pavements, etc., of Manhattan, and subsequent investigation by Governor Charles E. Hughes, of New York State, it became necessary to know the quantity of traffic on representative avenues and streets. I was employed as Consulting Engineer on Pavements, and among other matters recorded and reported to the Governor the traffic on several streets and showed its relation to the maintenance or neglect of the pavements. The heavy traffic streets in wealthy and influential districts, as Fifth Ave., are maintained in good order, whereas, the lighter traffic streets in poor districts have not been kept in repair. Traffic records have heretofore been made for 10, 11 or 12 daylight hours. Therefore for purposes of comparison with previous traffic, I made records for 11 daylight hours on various streets. The heaviest traffic recorded in New York for 11 hours was on Oct. 14, 1907. It was 11,170 vehicles, weighing about 13,360 tons, on Fifth Ave., between 33d and 34th Sts., or 279 vehicles or 324 tons per foot of width of roadway for 11 hours. The traffic on First Ave., between 26th and 27th Sts. for 11 hours on the same date was 4,445 vehicles, weighing about 6,734 tons, which was about 79 vehicles or 120 tons per foot of width of roadway for 11 hours.

The accompanying table shows the traffic on Fifth and First Aves. for 24 consecutive hours. This is probably the first time that traffic for 24 hours has been recorded in any American city.

NUMBER OF VEHICLES OF VARIOUS AVERAGE WEIGHTS ON FIFTH AND FIRST AVENUES, NEW YORK CITY, GOING BOTH NORTH AND SOUTH DURING 24 HOURS, FROM WEDNESDAY TO THURSDAY NOON, OCT. 9-10, 1907.

	Horse vehicles				Autos,	
	1 ton.	2 ton.	4 tons.	Total.	1 ton.	Total.
On Fifth Ave., Between 58th and 59th Sts.						
12-1 p. m....	437	69	30	536	230	766
1-2	421	107	20	548	184	732
2-3	296	60	11	367	142	509
3-4	583	86	24	693	331	1,024
4-5	661	88	17	766	400	1,166
5-6	537	42	9	588	329	917
6-7	484	46	1	531	275	806
7-8	156	60	3	219	115	334
8-9	165	37	3	205	54	259
9-10.....	122	12	0	134	75	209
10-11.....	119	9	0	128	70	198
11-12.....	117	13	0	130	71	201
12-1 a. m....	85	27	0	112	45	157
1-2	40	8	0	48	20	68
2-3	14	6	2	22	5	27
3-4	21	2	3	26	4	30
4-5	33	14	6	53	3	56
5-6	27	19	24	70	0	70
6-7	42	44	2	88	19	107
7-8	122	57	12	191	31	222
8-9	211	53	6	270	187	457
9-10.....	263	51	19	333	179	512
10-11.....	437	51	17	505	308	813
11-12.....	432	65	10	507	232	739
Totals	5,825	1,026	219	7,010	3,309	1,0379
On First Ave., Between 77th and 79th Sts.						
12-1 p. m....	96	44	3	143	1	144
1-2	165	45	6	216	0	216
2-3	183	60	13	256	3	259
3-4	149	73	9	231	3	234
4-5	108	80	7	195	0	195
5-6	104	91	4	199	2	201
6-7	83	42	2	127	1	128
7-8	41	22	1	64	0	64
8-9	33	11	0	44	0	44
9-10.....	19	7	0	26	0	26
10-11.....	3	5	0	8	0	8
11-12.....	3	3	1	7	0	7
12-1 a. m....	0	0	0	0	0	0
1-2	1	0	0	1	0	1
2-3	4	2	2	8	0	8
3-4	14	10	1	25	0	25
4-5	16	5	1	22	0	22
5-6	45	10	1	56	0	56
6-7	58	41	4	103	0	103
7-8	95	24	12	131	1	132
8-9	102	58	20	180	0	180
9-10.....	134	52	23	209	1	210
10-11.....	129	71	20	220	3	223
11-12.....	116	48	13	177	2	179
Totals	1,701	804	142	2,648	17	2,665

The estimated weight of Fifth Ave. vehicles and loads was 12,062 tons. The width of Fifth Ave. at the place of recording this traffic is 41½ ft. There were therefore 251 vehicles, or 292 tons, per foot of width per 24 hrs. This can be regarded as an average week-day traffic on Fifth Ave., between Ninth and 59th Sts. The Sunday traffic on Fifth Ave. is about one-fifth the week-day traffic.

The estimated weight of First Ave. vehicles and loads was 3,898 tons. The width of First Ave. at the place of recording this traffic is 56 ft. There were therefore 48 vehicles or 69⅝ tons per ft. of width per 24 hrs. This can be regarded as an average week-day traffic on First Ave., between 22d and 109th Sts. The Sunday traffic on First Ave. is very small, sometimes none is in sight for an hour or more.

Fifth Ave., New York, has probably the most numerous, if not the heaviest traffic in total quantity as well as per foot of width, found in any American city. It is exceeded by a few streets in Paris, London and Berlin. It is interesting to note the large proportion of automobiles now in use.

Records of street traffic help solve the paving problems of cities and should be made at reasonable intervals in every important city. The flow of traffic needs controlling, guiding and relief, not only on account of pavements but for other obvious reasons.

J. W. Howard, C. E., E. M.,
Consulting Engineer.

1 Broadway, New York, Nov. 1, 1907.

The Madeira and Mamore R. R. and Engineering in the Tropics.

Sir: The interesting and well written paper of Mr. Liebel published in your issue of Oct. 24 cannot fail to prove of interest to all railroad engineers interested in the development of new projects, and especially so to those who are or have been engaged in this work in undeveloped parts of the world, and particularly in the tropical parts of South America.

The letter is unfortunately a record of what only too frequently happens to such projects, whether it may be true in this case or not, and it is to be hoped that on further investigation, matters will not prove to be as bad as your correspondent evidently thinks they are. Mr. Elmer L. Corthell certainly has had wide and varied experience under similar conditions, not only in the Latin-American countries, but also in connection with the improvement of the Mississippi, and should have been able to anticipate the difficulties, which, although very real ones in any expedition of this kind, are such as have been and still are being overcome by American engineers in South and Central America, Panama, the Philippines and elsewhere.

It is quite likely that further particulars from those in charge of the expedition on the ground will show that many of the difficulties have been greatly exaggerated and that a great deal depends on the point of view. Your own comments as to Mr. Liebel's lack of knowledge of what had previously been done on the project, show that his powers of description of the incidents of the trip, which make his letter very interesting, are not equalled by his knowledge of the facts regarding the railroad.

The writer has had some little experience in railroad construction in tropical South America, and this experience, which he believes is probably very much the same as that of all others engaged in this class of work, is, that it is safe to count on at least 50% of the men who go from the United States to these countries returning home in less than three months unless extreme care is taken in their selection in the first place.

Most of these expeditions have been organized in the East in New York, Boston and Philadelphia and the majority of the men who have gone down have been city bred; they consequently do not take kindly to the life of a pioneer, and what to them are horrible and terrifying experiences, would be taken philosophically by the man used to roughing it, and to camp life on a railroad location survey, as nearly all Western railroad men and a few Easterners are.

There is no question but that every precaution should be taken to make adequate preparation before starting an expedition of this kind. The Chief Engineer, or at least his Principal Assistant should have had previous experience in tropical countries, so that while everything necessary is taken, there will be little that is superfluous. Every man of the first party to go down should have had previous experience of camp life—for business—should be capable of filling at least the next higher position and be paid accordingly, besides the necessary extra compensation for service in the tropics.

The necessity of filing a location of the line, or a part of it before a certain date is almost invariably part of any concession or franchise anywhere, and in this case does not seem very onerous. Ten kilometers, or approximately six miles, does not necessitate a large party, two or three experienced men who can speak the language of the country, provided with sufficient laborers, could do it easily in two or three weeks, unless the country is extremely difficult, which it probably is not in this case, and especially is this so in view of the work previously done. Two experienced men with a stadia outfit with the necessary laborers are all that are necessary to continue the reconnoissance of the whole territory to be explored.

Pending further details from the officials of the Railway Company, it would hardly be fair to make any criticisms except that it would seem that an unnecessarily large party of engineers was taken down at the start. As previously stated, two or three men, experienced not only in railroad location, but in work in tropical countries, under conditions which might, in this case, have been easily anticipated, and especially with a knowledge of Portuguese or even Spanish, could have done a great deal of preparatory work with native assistance. There should be no question that there is practically no reasonable limit to the salaries which might be paid to such men, or to the wages to be paid to a picked body of laborers to assist them, though in the latter case, some care has to be exercised as to the establishment of a precedent which might have to be followed throughout the construction of the road with all the laborers engaged thereon.

Mr. Corthell's cablegram apparently indicates that even now (Oct. 16) the preparations for a large party are not complete although the first party of engineers arrived at San Antonio in June. Under the conditions, the progress made is probably all that could be expected, but this only emphasizes the point that the first party should have consisted of the smallest possible number of picked men, every one of whom should have had previous experience under the conditions, which it might have been foreseen, would have been encountered in such a situation.

The general idea in expeditions of this kind is to pick up a number of very young men who have had probably some engineering experience, who are attracted by a slight increase in salary, and rush them off with a couple of tents, a few cases of canned goods, and the cheapest outfit of instruments that can be bought—anything is good enough for a railroad survey, transitmen are made locating engineers, rodmen, transitmen, and so on. After a few months two-thirds return to the United States with a long tale of woe, and by the time expenses of men to replace them are paid, it is generally found that it would have been much cheaper in the long run to have made adequate preparation at the start, and to take only picked men.

The experience at Panama has shown, what many engineers with tropical experience have long known, that in tropical countries adequate preparation, which of course should be made anywhere, is absolutely vital to the success of any enterprise, and absolutely necessary before any attempts to "make the dirt fly."

Yours very truly,

F. Lavis.

P. T., T. R. R. Co., P. O. Sta. 1, Hoboken, N. J., Oct. 16, 1907.

Sir: Having been identified with engineering work in the State of Amazonas, Brazil, for some six years, and knowing the country from the river to Acre, I naturally read the tale of woe connected with the survey of the Madeira & Mamore Railway with interest. It is an old, old story and one which 90% of the young men who go to that section carry back to the States.

Now, for the benefit of those of your readers who may contemplate going to that section, a few remarks concerning my experiences there may be of interest, and right here let me remark that there, as well as elsewhere, some men succeed and some fail.

Concerning the particular party of which your correspondent was a member, it so happened that the writer was aboard the "Grangense" on the day this party sailed and together with some of the ship's officers I was amused at the joyous and picnic-like air of the outfit. We were also a trifle surprised as Mr. Miller should have known something of the conditions existing in the Amazon valley, as some eight years ago he ran the survey for the lines of the Manaos Railway and did some paving in Manaos. Those of us who know this country have acquired the faculty of "sizing a man up" and we can tell with almost mathematical certainty just how long a man will last when he gets inside of Salinas.

North Brazil is not an unhealthy country for the man who is fitted by nature to live in that country, and I have yet to see any stagnant water or death-breeding swamps thereabout. Friends of mine in Para have informed me that this party landed in that place with a full equipment of sporting goods and were very eager to penetrate the forests in search of jaguars and other wild animals. Now this was very unwise and personally I always steered clear of any vicinity that smelt of cats or snakes. Furthermore, those forests contain tribes of cannibals who are better left alone. They concern the State police and it is better to allow them to go their way unmolested. I saw 150 marched through the streets of Manaos one day on the way to their own funeral, and they were not pleasant looking people I assure you.

During over six years' continuous residence in Amazonas, both in Manaos and up the rivers, I never had a moment's illness, and it is my opinion that any man who

leads a regular life, avoids excesses and does not expose himself to unmentionable diseases with which the population is afflicted, need have no fear.

But there is one remark that I should like to make, and that is that no man who carries any superfluous flesh or who weighs over 150 lbs. has any business in that section. If he does he will not escape; I do not say that he will die, but the fever will surely attack him sooner or later.

Furthermore, a man must understand the Portuguese language; he must be experienced enough to discern the good as well as the bad in the natives, and must cultivate their friendship; he must study their ways and be able to turn their peculiarities to his own advantage without giving offense; he must be able to inspire confidence and to outwardly ignore danger and annoyance.

Once the natives have confidence in him, they will go out of their way to do him favors and will stick to him and fight for him if necessary. Men occupying important positions must know how to take care of themselves, and must be endowed with sufficient judgment to procure suitable food and quarters from the resources of the country.

Work is usually pushed there at a high pressure for labor is expensive and forethought pays well. The heads of an enterprise usually have troubles enough of their own without being bothered with the annoyances of their assistants. The reason they have assistants is to help them. Every head of a department must know how to take care of himself and his labor.

And last, but not least, any engineer who wishes to successfully carry on work in that region must have an inborn love for adventure under uncomfortable circumstances, and must love his work for its own sake. Men who are fond of personal comfort, a fixed routine, constant guidance and advice, hours for recreation and the advantages of civilization; and who think that they can go down there and make things go without an extraordinary application of energy, had better stay at home. Confidence in, and loyalty to, their chief is the keynote of success there as elsewhere and work must not lag. A showing must be made, for "something doing" attracts labor very quickly there and "nothing doing" disgusts them just as quickly.

The Manaos Harbor, of which the writer was mechanical engineer, was built in less than one year and was paying dividends in two years. The chief engineer of this enterprise was Mr. Antonio de Lavandeira, a Rensselaer Polytechnic Institute graduate of the class of '77. Now it would be natural to suppose that a man of this age who had spent probably fifteen years in Brazil as the head of important enterprises would consider himself entitled to some personal comforts. As a matter of fact Mr. Lavandeira's working hours lasted from 4.30 a. m. to midnight and he seemed possessed of the secret of the fourth dimension and to be able to be in several places at the same time. His decisions were made instantly and every sub-engineer had his work to do and was expected to carry it on without help from others. Each engineer had authority to govern his department as he saw fit, being responsible only to the chief, who, in turn, assumed all responsibility to the company. Every day in the year except Good Friday was a working day and employees were not encouraged to live with each other or to give opinions on how other departments should be conducted. Common sense sanitation was adopted and violation of rules meant instant dismissal irrespective of the standing of those who violated them. It was simply work, two meals a day and a few hours' sleep each night. The result of this order of affairs may be observed to-day in the successful outcome of the harbor works, the biggest thing ever attempted on the Amazon.

About two years ago Mr. Lavandeira took charge of the city water supply at Manaos. At that time the place was little more than a scrap heap, the city often being without water for weeks at a time. In six days a transformation had taken place and the city to-day can boast of a reliable and unfailing water supply. We simply felt that our honor was at stake and made up our minds to win.

As a typical example of what an engineer has to expect in North Brazil, it might be interesting to relate the writer's experience in building the electric light plant at Labrea, on the Rio Purus, a locality not far from San Antonio, twelve days' journey from Manaos.

In the latter part of 1901 I was in Manaos and laid out plans and bid on a lighting and pumping station for the town of Labrea, a place somewhat like San Antonio. I had never seen the place and time would not permit of a personal investigation. As much information as possible was gathered from the Mayor of the place, who was in Manaos to make the contract. A synthetic method of diagramming all necessary material and supplies was devised.

I hurried to New York, purchased everything down to the last coil of rope necessary and arranged the shipment to go in one steamer. I arrived in Manaos the middle of August, personally supervised the unloading of the material, landed the same, and fairly slept with it until the custom-house people had finished their inspection, in company with Abraham Bytton, who was forced to leave his electric light plant at Manaos in the hands of his native employees, the man whom we had sent from the States refusing to stay in Manaos during our absence, although we had secured him for just that purpose. I sailed from Manaos the latter part of September, aboard the A. S. N. Co.'s steamer "Bencellos," towing our lighters loaded with material. We took six picked men with us from Manaos whom we paid 20$000 (six dollars) per day. You may rest assured that they did not desert us for we kept our eyes wide open at all landings; and up the Brazilian rivers there are things more unhealthy than malarial fevers.

Naturally we fully realized before starting that we would be cut off from all communication, supplies, etc., so we did not expect to get the latest market quotations every morning.

On arriving at Labrea, which was reached in a terrific rain squall, we had some anxiety concerning our cement, which had to be hoisted from the hold of the steamer to the lighter. The steamer would wait only long enough to get this cargo out. If it became wet it was none of their affairs. Another rather annoying circumstance was that the Mayor had died and the man who had taken his place did not want the electric light plant. Consequently nobody paid any attention to us. That night we slept in an abandoned hut. There was no supper that night and our breakfast next morning consisted of some bread and sausage eaten while sitting in our hammocks discussing the outlook. At 6.30 Mr. Bytton started out to interview the acting Mayor while I paid a visit to the lieutenant in charge of the jail and procured the use of his prisoners to unload our lighters. We were both successful in our undertakings, the Mayor presenting us with sufficient space to build the plant and I got the prisoners for 7$000 per day each, about forty men.

At noon we started our cargo, and, to make a long story short, took two weeks to get our supplies to the town, which was 70 ft. above the river; put the plant up in five weeks, and then had a celebration. The town gave a ball in our honor. I think they made thirty speeches that night and insisted on our drinking "champagne" (at least the labels on the bottles said it was that) after each speech. After we ran the plant for fifteen days we departed. I certainly do not regret the experience, even though my apparel consisted of rubber boots and a suit of pajamas most of the time.

Probably the most exciting experience was starting up for the first time. There was no water supply, so we had a bucket brigade, operating between the river and the plant, to fill the boiler (a Babcock & Wilcox) with water. Now our pumps were electric, so things simply had to go. It took a long time to pump the air out and I shall never forget the hair-raising experience as I crawled along the suction pipe trying to listen for the liquid to rise, while Mr. Bytton kept reporting the level of the water in the boiler from the door of the power-house. I was highly delighted, and almost died of heart failure when I saw a 4-in. stream pouring into the main reservoir. That night while making a tour of inspection I found a crowd of natives bathing in the reservoir, so personally I never had the pleasure of drinking any of the town water supply. I have related the foregoing merely to show those who are thinking of going to Amazonas what they have to expect.

Before young men go there they should realize exactly what the place is like, preferably personally interview those who have been there, but after deciding to go, go, and go with a determination to win.

It is a country where originality, pluck, perseverance and real knowledge pay and when you get there look for the good and not the bad. Don't think because you wake up in the morning and find the vultures sitting on your window sill they are waiting for you. They are wise birds and probably only are waiting for some of the bats that you have killed in the small hours of the morning. If they wanted you they would take a short cut to the cemetery.

Charles J. Seibert.

81st St., Troy, N. Y., Oct. 25, 1907.

[In addition to the above letters and the one from Mr. Carlander, printed last week, we have received a letter from Mr. E. L. Corthell, dated at London, Oct. 21, from which we extract the following:

The Madeira & Mamore Ry. Co. has from the start done all in its power to provide for and take good care of its engineers, and of all its employees. It has built a roomy, comfortable hospital, sent to San Antonio a refrigerating plant and abundant and suitable provisions and medicines, and is now erecting comfortable quarters, clearing away the tropical undergrowth of the forest, establishing good camps at various points along the route, and is in every way doing all it possibly can to preserve the health and comfort of all its employees.

It could hardly be expected that an advance corps of engineers, who had the task of locating immediately a part of the line—in order to comply with the terms of the concession—would find everything for their comfort or to their liking in a tropical jungle. The company has before it the experience of a former enterprise which attempted the construction of the Madeira & Mamore Ry., and it does not intend to neglect the care of its men.

The contracting firm of May, Jekyll and Randolph I know personally. They have done excellent railroad construction work in the swamps of Guatemala and in Cuba, and are able men, experienced in such work in a hot climate.

Personally I have no interest in this project, but being the Chief Engineer of the Port of Para, I am naturally interested in the construction of a railway that is going to bring to Para the products of the vast country above the Falls of the Madeira in Bolivia and Brazil.

Apropos of Mr. Liebel's criticism of Chief Engineer Miller for agreeing to file a location for the first ten kilometers within 30 days, we are in receipt of a letter from a prominent member of the Collins expedition of 1878, from which we quote as follows:

The right-of-way for 20 miles south from San Antonio was cleared of timber and brush for 100 ft. in width. After the first six miles the work is very light indeed. It would be an easy matter for any competent man to relocate this line and 100 years of work could not improve the old location.)

On the other hand, as the writers of the above letters assume that the engineers who left the party at San Antonio were "tenderfeet" unused to the conditions of tropical railway work, it is fair for us to state that Mr. Liebel, the writer of the article in our issue of Oct. 24, has had half a dozen years' experience in Mexico and Central America, and that another engineer who left the party had had extended experience in railway surveys in Bolivia.—Ed.]

REPORT ON SEWAGE DISPOSAL OF THE CALUMET DISTRICT THROUGH THE CHICAGO DRAINAGE CANAL.

In our issue of Jan. 31, 1907, we abstracted at length two very interesting reports, the one relating to the effect of the Chicago Drainage Canal on the levels and navigation of the Great Lakes, and the other on the treatment of the sewage of the Calumet District by sprinkling filters instead of disposing of it by discharging it through the Chicago Drainage Canal. The first report was prepared by the International Waterways Commission, and, in brief, strongly recommended that the volume of water to be abstracted from Lake Michigan by the Chicago Drainage Canal should be limited to 10,000 cu. ft. per sec., and that the sewage of the Calumet District should not be diverted to the drainage canal. The second report was made by Messrs. Hering & Fuller, Consulting Engineers, of New York City, and was confined chiefly to a study of the possibilities of purifying the sewage of the Calumet District. The engineers named concluded that it would be feasible to purify the sewage, and that for that purpose sprinkling filters would be the best method.

During the past summer, Mr. Rudolph Hering, M. Am. Soc. C. E., of Hering & Fuller, was engaged by the trustees of the Sanitary District of Chicago to make a broad general study of the relative advantages of disposing of the Calumet District sewage by dilution through the drainage canal and by sprinkling filters. Mr. Hering's report was recently submitted to the president of the Sanitary District of Chicago. Taking into account the revenue to be derived from water power, Mr. Hering concluded that disposal by dilution was much the cheaper of the two methods under consideration. He also gave reasons in support of the opinion that a total of 14,000 cu. ft. per sec. of water might be diverted from Lake Michigan (10,000, as now, through the drainage canal proper, and 4,000 additional through the Calumet branch) without injury to navigation in the Great Lakes. Through the courtesy of Mr. Hering we are enabled to present herewith the résumé and conclusions of his report. We also reproduce two diagrams prepared by Mr. Hering to accompany his report. Fig. 1 shows the location and the relative sizes of the Chicago Drainage Canal, the proposed Calumet branch, and other connections with the main canal; also, the velocities at various points in the canal and proposed main branch. Fig. 2 presents graphically

figures which are also presented in tabular form, showing the relative annual costs of sewage disposal by means of sprinkling filters and by means of dilution, the latter, with and without the reduction in cost that would be effected by the utilization of water power at Lockport and at both Lockport and Joliet. Mr. Hering's conclusions are as follows:

RESUME AND CONCLUSIONS.

A brief résumé of what has been stated above and the conclusions resulting therefrom may now be given as follows:

It was your wish to know the most desirable method of disposing of the sewage of the Calumet Subdivision of the Sanitary District of Chicago without causing a nuisance or pollution of the lake water, irrespective of previous recommendations or legal restrictions. In considering this subject you desired that a comprehensive view be taken, so that any recommendation made today would be in line with what appears as a proper solution in the distant future. You also wished to know the estimates of cost and any collateral benefits that would be associated with whatever method I should recommend.

The Calumet Subdivision is herein understood as being that part of the district which lies south of 87th St., because, for the territory north of the same, provision for sewerage now exists or is planned. The Calumet River passes through its southern part and resembles, both in ordinary and flood discharges, the Chicago River before its flow was reversed. There is also a low divide a few miles to the west, beyond which the drainage flows into the Desplaines River at Sag and thence to the Mississippi River. Much of the territory is already provided with sewers which take both sewage and rain water, except a small area at Pullman where these waters are separated.

The lowness of most of the area requires that much of the sewage and rain water must be pumped. At 95th St., near the mouth of the river, there is a pumping station for this purpose. Under flood conditions the sewage enters the lake which, in the future and perhaps already, no doubt must endanger the wholesomeness of the water at the Hyde Park intake.

There are two methods which are available for properly disposing of the sewage in the Calumet region, so as to prevent the pollution of the water supply of the city and to prevent any nuisance in the rivers or on land. One is its purification by means of sprinkling filters. The other is by repeating the method now used in Chicago, namely, building a canal from the Calumet River across the low divide to join the present Sanitary and Ship Canal at Sag and, by reversing the flow of the Calumet River, to carry in it sufficient water to properly dilute the sewage. [See Fig. 1.] Whenever this flow is less than required, the deficiency is supplied from the lake; whenever it is greater, the excess flow goes to the lake. To guard against sewage being carried into the lake at such times, it is necessary to build intercepting sewers to discharge it into the canal and not into the river.

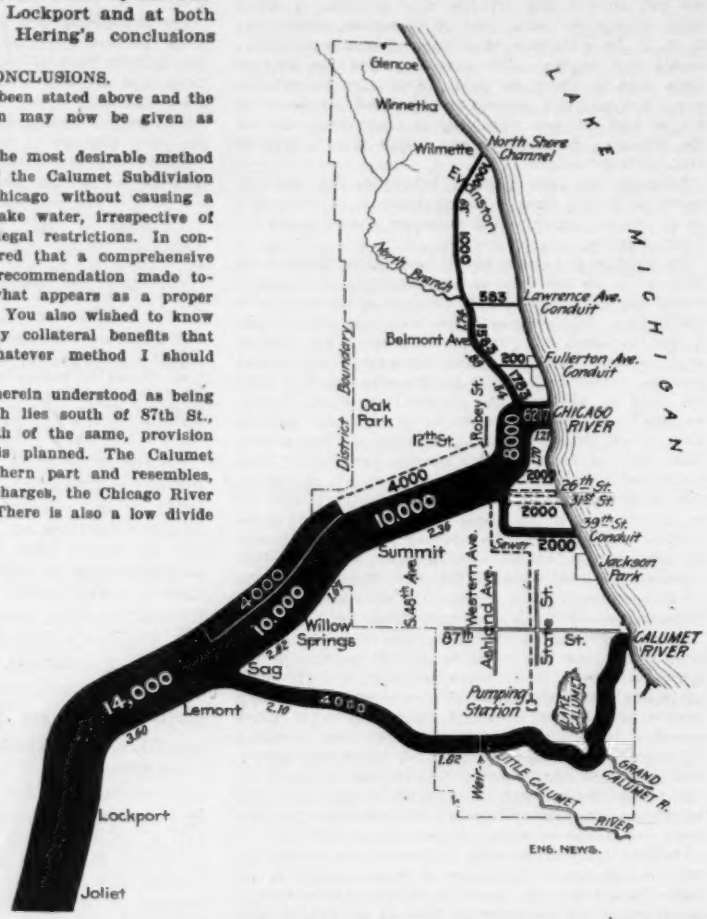


FIG. 1. DIAGRAM SHOWING PROPOSED CALUMET RIVER AND OTHER CONNECTIONS WITH CHICAGO DRAINAGE CANAL.

(The black area indicates relative discharge capacity of finished and proposed works. The heavy broken lines indicate alternative proposals. The large whole numbers indicate discharge capacity in cubic feet per second; the Italic numbers, expressed in units and decimals, indicate mean velocities in feet per second.)

At the request of the International Waterways Commission the various "available methods of disposing of the sewage of the Calumet area, other than by dilution," were studied and sprinkling filters recommended as "being the cheapest, both in cost of construction and operation, and accomplishing an adequate degree of purification." Under your instructions this method was compared with the dilution of the sewage in the Calumet-Sag Canal.

The dilution method was studied from the experience gained by its application in Chicago, since the Sanitary Canal has been opened. The canal was originally designed to carry 10,000 cu. ft. per sec., sufficient to dilute the sewage of 3,000,000 persons. Above Summit provision for this population is being made, as indicated on the appended diagram. Below Summit the canal is now capable of carrying 14,000 cu. ft. per sec., but between Summit and Sag it is proposed to carry only 10,000 cu. ft. per sec., and at Sag receive 4,000 cu. ft. per sec. through the proposed Sanitary Canal from the Little Calumet River.

This project will protect the lake water from receiving any sewage. It will permit of controlling the proper flow in the canal at all times and dilute the sewage of 1,200,000 persons in the same manner as the main canal now built.

In order to compare the two projects, it is necessary to know their true values, which must be based upon their cost and collateral advantages. A most important item for those who pay the taxes is the cost. This is obtained from a balance between expenses and receipts. The expenses should be stated as the total annual cost, made up of operating expenses and fixed charges for interest, etc. The receipts should be given as returns from the sale of products. There is no money return from the sprinkling filters, as their product has no value. But there is a return from the dilution project, because the flow of 4,000 cu. ft. per sec. can drop 66 ft. and develop 22,500 efficient HP. This earning power produced by the money spent in building the canal to supply the water is an asset as much as if it had been built especially for water-power purposes. It is an asset as much as the products yielded from mineral lands originally bought from the Government, and as much as rents secured from a building.

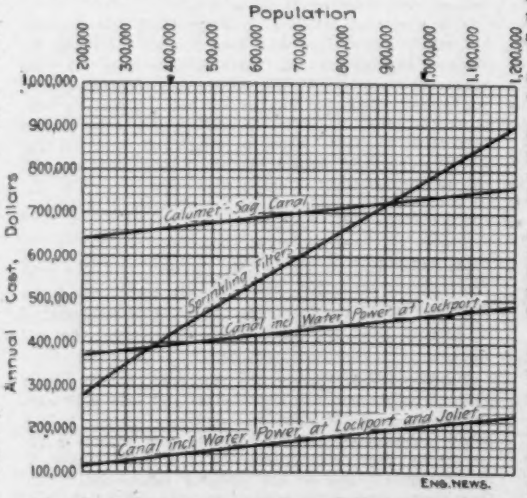


Fig. 2. Diagram Showing Relative Annual Costs of Sprinkling-Filter and Calumet-Sag Canal Projects for Disposing of the Sewage of the Calumet District, Chicago.

(The cost figures include both fixed charges and operating expenses, and also take into account the cost of collecting sewers and of pumping.)

The accompanying diagram gives the net annual cost of the two projects in a graphical manner, so that the relative costs can be seen at a glance for various future population of the Calumet region between 300,000 and 1,200,000. There is also inserted a table, showing this cost for an early population of 300,000 and later population of 1,200,000, for sprinkling filters and for the Calumet-Sag Canal, first, its actual cost, second, its cost with a return for power at Lockport, and third, with an income at both Lockport and Joliet. This table indicates that for an early population the canal project would cost annually about one-third as much as filters, and for a population of 1,200,000 about one-fourth as much, not considering any value which the canal may have for purposes of navigation. The table further shows that when the population is 1,200,000, the presumable annual cost of the canal project, even without any returns from the sale of power, would be $156,600 less than of sprinkling filters. [See also the diagram, Fig. 2.] Even a material variation in the cost would not alter the general conclusion that the canal is the cheaper project.

Annual Cost, Including Operation and Fixed Charges.

Installation for a population of	Sprinkling filters.	Calumet-Sag Canal: Cost of canal alone.	Calumet-Sag Canal: With power at Lockport.	Calumet-Sag Canal: With power at Lockport and Joliet.
300,000	$360,240	$656,900	$384,100	$128,800
1,200,000	900,300	763,700	490,900	235,600

The cost comparison alone would decide which project is the more desirable one for the citizens of Chicago, if there were not objections apparently more or less serious that had been raised against the Calumet-Sag project. These objections, I believe, can be satisfactorily answered. The most important of them are here restated.

A question has arisen as to whether it would not be more economical to utilize the main canal and its feeders to their full capacity for the central district of the metropolis through which it runs, and to erect sewage filtration works for all the more distant parts, such as the Calumet region.

The annual cost of works for carrying out this suggestion would be $122,000, considering an income from the additional flow of 4,000 cu. ft. per sec. But this expenditure does not provide any relief whatever for the Calumet area, the cost of which for filters can be taken from the annexed diagram for whatever population this area might then be assumed to have. Assuming it to be 700,000 when present Chicago has attained 4,200,000, then this annual cost would be $600,000, in addition to the above, while the cost of the Calumet-Sag project would be only $175,000.

Another objection has been raised on the ground that there would be a large loss in the investment if used to carry only 10,000 instead of 14,000 cu. ft. per sec., for which flow it already provides.

This apparent loss is compensated, perhaps fully, by decreasing the velocity of the current nearly 30% and offering correspondingly better facilities for handling vessels and making docking easier.

The most important objection comes from the International Waterways Commission, which says that the diversion of 14,000 cu. ft. per sec. would lower all of the lakes from 6 to 8½ ins. and that the cost of restoring the original depths would be about $12,500,000. It grants the diversion of 10,000 cu. ft. per sec. without further question for sanitary purposes, whatever the effect upon navigation might be, but recommends that the Government of the United States prohibit the diversion of any further amount.

Should the Sanitary Canal cause the lowering stated above, the prohibition would certainly be in the interest of Chicago no less than of the entire lake region.

It seems evident, however, from the facts in the case, that whatever lowering would be caused by the diversion through the Sanitary Canal, is already almost completely compensated by works partly done, or recommended to be done by the Commission, at Sault Ste Marie.

The Commission has recommended the establishment of a low-water level of Lake Superior of 601.7 ft. above tide, to be held by regulating works, and a high-water level of 603.2 ft., or 18 ins. higher. The lowest annual mean level of Lake Superior occurred in 1879 and was 601.43.

The most protracted low-water period since 1860 occurred between the years 1888 and 1893. During this period the lowest annual mean discharge at Sault Ste Marie was 57,420 cu. ft. per sec. in 1892.

Computing herefrom the depth of storage necessary, after allowing this discharge to continue down the lakes, to furnish in addition a continuous flow of 14,000 cu. ft. per sec. to be diverted into the Mississippi valley at Chicago, we find it to be 21.6 ins. If we add this depth to the lowest annual mean level of Lake Superior, which, since 1860, was 601.43, we get an elevation of 603.23, or but a trifle higher than the high-water level recommended by the Commission.

Therefore its recommendation, if adopted, would create by storage during high waters in the lake, almost the entire flow of 14,000 cu. ft. per sec. desired by Chicago

for its two sanitary canals, without lowering the lakes in the least, nor requiring any expenditure for restoring the original depth of the harbors, channels and canals of the lake system.

Other countries spend large sums of money for water storage to increase the summer flow of their rivers. Our great lakes are the most magnificent storage reservoirs of the world, high above the ocean level, and large enough to send, by gravity, great amounts of water to the sea in two directions for the benefit of commerce.

Assuming now that there cannot be an injury to navigation in the Great Lakes from the diversion into the proposed sanitary canals, a few collateral benefits of the Calumet-Sag Canal over the sprinkling filters may be mentioned.

A final disposition of sewage by at once diluting it with a sufficient quantity of running water has the advantage of simplicity in operation and is, therefore, always preferable to any method of treatment, because it requires less attention, care and labor, and, from a sanitary point of view, is quite as satisfactory, if the sewage is properly mixed with the diluting water and not used as a potable supply until actual oxidation has made it safe.

As yet the least expensive method of sewage treatment has not been developed to a final state. No municipal plant of sprinkling filters has yet been operated in America, although several are now under construction. We may therefore expect that experience, particularly in northern climates, may indicate some desirable modifications, although we expect them to be only slight, and in southern climates insignificant. On the other hand, the dilution method of sewage purification, being the prevailing one and the oldest one in use, is thoroughly known as to what it can do and what it cannot do. We may therefore consider its works to be more permanent.

Even if the comparison of cost, simplicity and permanence, contrary to fact, had all indicated no distinct advantage for the dilution project, the present case introduces a feature which constitutes a decided advantage in favor of the Calumet-Sag Canal. Its size, location and moderate current necessarily combine to make it available for a navigable waterway connecting Lake Michigan with the present Sanitary and Ship Canal at Sag.

That there is already a marked tendency to concentrate heavy and bulky freight at the Calumet River is shown by the fact that, while the tonnage of the Chicago River has remained almost constant for 18 years, the annual increase of tonnage of the Calumet River has been quite rapid, and now is more than one-half of that in the Chicago River.

If regulated for slack water navigation, it is well known that alluvial and silt-bearing rivers have the disadvantage of perpetual dredging. If regulated for large quantities of lake water to materially augment the flow, such dredging will be much reduced and cause a permanent advantage. This view is endorsed and amplified by a remark made in Chicago in 1906 by Gen. O. H. Ernst, U. S. Army, who said:

> In a future not remote, larger amounts of water (than 10,000 cu. ft. per sec.) may be needed for sanitary purposes, and channels deeper than 14 ft. will then become practicable in the open alluvial portions of the Illinois River.

After carefully weighing all the advantages and disadvantages of the two propositions, it is my opinion that the proposed Calumet-Sag Canal is not only the more economical one for disposing of the sewage of the Calumet region, but that it has still other advantages of more or less weight.

DISTRIBUTION OF IRRIGATION WATER FROM CANALS IN THE YAKIMA VALLEY, WASHINGTON.*

By S. O. JAYNE.†

The overabundance of water which has in past years been available throughout the Yakima Valley accounts for the very crude and totally inadequate means for the just and equitable distribution of water among irrigators. It is a deplorable fact that not a single canal system in the entire length of the Yakima Valley is to-day in such a condition that even an approach to equitable division and distribution can be made. Many of the smaller canals are without any means for measuring the water used, and many of the larger ones on which some attempts at measuring have been made might almost as well be without anything, for, on account of the crude construction, lack of uniformity in placing, and in the conditions under which they operate, such devices as are now in use are of practically no value for taking measurements even approximately correct. They serve merely as rough guides for the ditch tenders, helping them to compare the discharges of individual deliveries from day to day, and also help the consumer to imagine he is getting his just portion of the water.

*From Bull. 188 ("Irrigation in the Yakima Valley, Washington"), Office of Experiment Stations, U. S. Department of Agriculture.

†Irrigation Manager, Irrigation and Drainage Investigations, Office of Experiment Stations, Washington, D. C.

Several of the largest irrigation companies contract to supply definite amounts of water to consumers, but without exception these companies have in the past delivered many times the contract amounts. Others of the large companies are supposed to give a certain proportion of the flow, depending upon the amount of stock held by the consumer. So long as every irrigator gets as much as he can use it makes no material difference to him whether the distribution is uniform, or whether he gets more or less than some other farmer; but let the supply run just a little short and then it is very desirable to know more definitely what is being delivered. It is then that every farmer accuses his neighbor of stealing his water, or the ditch tender of favoritism toward certain parties, and it is safe to say that this same matter of the distribution of water is the cause of more animosity, strife and dissension among the farmers, and friction between them and the ditch riders or canal managements, than any other one thing in connection with irrigation work.

While in the past the companies have been more than liberal with water, and have, where contracts called for 1 cu. ft. per sec., given two to ten times this amount, and the cooperative ditches have had sufficient to satisfy all, these conditions can not go on forever, and it is not right that they should. With the thousands of acres still dry, which with water would make homes for hundreds of families, it is not fair to the Yakima Valley or to the State of Washington that the extravagant and wasteful methods of irrigation which have prevailed in the past should continue indefinitely; and they will not.

One of the first steps in the organization of a system for distribution should be to provide means whereby the canal superintendent may know more about the canal in his charge. He should be provided with a current meter, or at least have some means of determining how much water is being diverted by his canal, and should further be able to know what becomes of it afterward. He should be able to know from day to day just what is being drawn from the canal by each of the laterals, and the number of acres watered by each one. A careful record of distributions should be kept throughout the season, as such records will be valuable as guides for future division, will give information regarding the duty of water, and may also be worth something as evidence in cases of dispute which often arise over water distribution.

In order to make such a system effective the canal superintendent at least, and if possible the patrolmen or ditch riders as well, should have a clear understanding of the common ways of measuring water over weirs or by miner's methods, and be able to install devices of this kind.

The matter of providing and maintaining satisfactory measuring devices is the most perplexing and difficult one to be encountered, and, as was stated above, nothing of the kind has yet been made to satisfy all conditions. The miner's method has been the commonest means of measurement in the past in this valley. At least a half dozen different styles of boxes have been or are being used. There seems to be an almost utter lack of uniformity between them, and even on the same canal it would be difficult to find any two boxes with governing conditions entirely similar, so that there are as many different miner's inches as there are boxes.

The court of Kittitas County has defined the miner's inch as the amount of water which constantly flows through an opening 1 in. sq., through a plank 1 in. thick in the side of a box in which still water is maintained at a constant depth of 4 ins. above the top of the opening. In some other parts of the valley the boxes are made with orifices 2 ins. high, and have the water stand 6 ins. above the opening. Boxes of this type are now in use under the Sunnyside canal in Parker Bottom, where water is taken out to supply lands which were formerly supplied by the old Konnewock ditch. The orifice is made 2 4ns. high and usually about 2 ft. long, and there is an adjustable slide by which the length of the opening may be regulated. The size of the boxes is not uniform, but usually they are about 4 ft. long and from 18 ins. to 2 ft. wide, with an iron plate overfall extending the length of the box on the side opposite the opening for discharge. The water is turned into the box until it is level with the crest of this overfall, and the head-gate is then locked. Two of the most common defects found with this mode of measuring are the failure to check the entrance velocity and to provide free fall at the outlet. The water enters most boxes with a rush, sometimes with a sheer drop of a foot or more, and it is the rule rather than the exception with the Konnewock boxes to find the water in the lateral backed up so as to at least partially cover the orifice through which the surplus is wasted.

The Hubbard, Fowler and Moxee canals near North Yakima use rectangular weirs for measuring water supplied to farmers. These are made with no end contractions, and consist merely of a plank with beveled edge set in a short flume or box. The boxes are built 1 ft. high, 2 ft. wide, and of a length sufficient to reach through the bank of the canal, usually about 10 to 14 ft. A gate set at the end on the inside of the canal bank regulates the entrance of water which passes over the weir board near the other end. This is 6 ins. high, and in the boxes noted was set with the beveled side up-stream. Such boxes can be of no use whatever for making accurate divisions of water and are described merely to show one of the many very crude methods now in use.

Three canal systems have adopted the Cipolletti weir, which, if properly installed and attended to, is perhaps the best method now in use for making careful measurements of water, and we would recommend its wider adoption. However, there are a number of conditions which it is necessary to observe in connection with the use of this weir in order that the results may be relied upon, and, so far, not sufficient care has been taken to keep the weirs in proper condition.

(1) The length of the weir should be sufficient to permit all water needed to pass over it without the depth in any case exceeding 2 ft.

(2) The end and bottom contractions of the weir must be complete. To secure this (a) the crest of the weir must be horizontal and the sides must be inclined with a slope of 1 horizontal to 4 vertical; (b) the crest of the weir must be perpendicular to the axis of the ditch; (c) the up-stream edge of both crest and sides of the weir must be sharp, and the walls cut away therefrom to prevent the creation of a vacuum; (d) the distance of the crest of the weir from the bottom of the flume must be three times the maximum depth of water intended to pass over the weir, and the distance from the end of the crest of the weir to the sides of the flume must not be less than twice the maximum depth of water to flow over the weir.

In the spring of 1904 the management of the Sunnyside canal undertook to improve methods of distribution, and as this is the largest system now in operation in the Yakima Valley, some further description will be given regarding what has been done.

DISTRIBUTION UNDER SUNNYSIDE CANAL.

The main canal is 57 miles in length, and carries between 600 and 700 cu. ft. of water per sec. One hundred and fifty to two hundred diversions are made from the canal. These diversions range in amount from 1 cu. ft. per sec., or less, up to 15 or 20 ft., and supply laterals from a quarter of a mile to 10 or 12 miles long. These laterals in general follow the crests of ridges or elevations, roughly at right angles to the main canal. The farms average about 20 acres, and in most instances each farm receives from the laterals an individual delivery of water, for the measurement of which in most cases weir boxes with adjustable gates have been supplied at the company's expense. Many of the laterals in this way supply water to from five to thirty different farms. The Snipes Mountain lateral, over 12 miles in length, with a number of large sub-laterals, constitutes a system larger than that of many independent canals of the valley.

With this great volume of water to be equitably divided among so many different laterals, and then to be again fairly distributed to the hundreds of individual farms, the magnitude of the undertaking should at once be evident and the need of system doubly apparent. In the endeavor to establish an adequate system for such distribution, the work of placing Cipolletti weirs at the heads of laterals and weir boxes at points on the laterals where individual deliveries are made, was begun a number of years ago. This was an excellent beginning, and the company finally succeeded in having at one time means of measurement for a majority of its deliveries, but the entire plan was never carried out.

In the spring of 1904 the writer became associated with this company in connection with the work of distribution, and an attempt was made to further perfect the methods which had been in use. The weirs at the heads of the laterals had received no attention, and scarcely any were in shape for use, so the first step taken was to repair the old weirs where they existed and place new ones in laterals where they were lacking. As was explained before, the miner's method is used for measuring water along the first 8 or 10 miles of the canal to the old Konnewock lands. Little could be done with these boxes except to level them up.

The repairs required on the weirs consisted principally in cleaning or enlarging the pools or channels above them in order to give the proper contractions and to reduce the velocity of approach and to raise the crests of the weirs so as to provide a free fall for the discharge. To get the necessary fall often required that the crests of the weirs be placed within a foot or less of the level of the water in the main canal at ordinary stages. In order that the supply need not be entirely shut off when only a small head was carried in the canal, provision was made whereby openings could be made beneath the crests of the weirs. It is often necessary to get water into such laterals early in the spring or late in the fall when not enough is in the canal to allow the weir to be used. Here is one of the most serious difficulties encountered in connection with the use of weirs, or for that matter any other practical

means of measuring diversions. The farmers wish to irrigate all the land possible and locate their laterals or head ditches just as high as they can and get water into them, which does not leave the fall which a weir requires. The miner's boxes need still a greater margin, and for discharges of only 1 to 2 cu. ft. per sec. it is not practicable to use rating flumes, so such diversions will have to be changed or, if continued, be regulated by guess as they have been in the past. In developing new irrigation districts this difficulty should be guarded against by prohibiting the diversion of water from the canal at a height so near the water level in the canal as to make the measurement of the water impossible.

In some places where the lands adjoining the canal sloped away more rapidly the weirs had ample fall, but were set so close to the outlet from the canal and so much below the level of the water in it that the water would shoot through the weir at a very high velocity. Such weirs were raised or baffle boards were put in the channels near the outlets from the canal so as to check the velocity.

To provide a convenient means of measuring the depth of water passing over the weirs 3 × 4-in. posts about 3½ ft. long were set in the channels several feet above the weirs, with the tops projecting 6 to 12 ins. above the water which would ordinarily pass over the weirs. To the side of the posts blocks were securely nailed so that the tops would be just level with the crests of the weirs. The depths of these blocks then gave the depths passing over the weirs. Later, painted scales graduated to quarter inches were tacked to the sides of the posts so as to show the depths on the weirs. This made it possible for the patrolmen to read these without dismounting at each lateral.

After providing the means of making measurements of diversions, the next step was to start a system of records. In order to do this each lateral was numbered. If the diversion was made at a point 10.3 miles below the intake of the canal the lateral was designated as lateral No. 10.3, and so on. This system not only describes the location of each lateral, but permits the establishing of new laterals without interfering with the numbers of others. On the headgate structure of each lateral was nailed a white block 1 × 6 × 8 ins., upon which the number was stenciled in large figures with black paint.

The patrolmen were supplied with weekly report cards, upon which was recorded daily the depth of water passing over each weir of his division. At the end of the week these cards were forwarded to the office at Zillah, where the data were placed upon monthly report sheets and filed.

That there might also be some check upon the water in the main canal, a gage rod was placed at the beginning of the "beat" of each patrolman, and daily records of these gages were included upon the weekly cards; but as these were to give daily the flow in the canal at these points, the gage heights were telephoned to headquarters each morning.

These gages, with the exception of the one at the intake of the canal, were placed in wooden boxes set in the canal banks, the purpose of this being to have the water quiet in order to permit a more accurate reading. The box at the head of the canal is made of concrete.

Practically all the work of actual distribution is attended to by the patrolmen. They regulate the gates which supply the laterals, and also have to look after the division of the water to the ends of them. The measuring boxes, through which the individual deliveries are made, have never been kept in proper repair, so that the division of the water after leaving the canal is largely a matter of judgment on the part of the patrolmen. The acreage supplied by each lateral was ascertained as far as was possible without making actual surveys, and this information was of much value in the distribution. This is one matter which should be determined carefully. However, it frequently happens that a farm may receive water from two or three different laterals, which makes it difficult at times to find out just the exact number of acres served by each. It is necessary especially for the patrolmen to know the number of acres supplied from each box in his charge.

As the work is divided at present there are ten regular patrolmen in charge of the Sunnyside canal system, and over them is a canal or water superintendent. Upon these eleven men rests the responsibility of distribution. With so much territory to cover it is not possible for a patrolman to go over the main canal each day and also inspect the deliveries on all the laterals of his beat; consequently no great amount of attention has been given to the careful division of water from the laterals except during the month or two when water is scarce. At such times a few extra men are sometimes employed for this work. In the early part of the season, when there is plenty of water, if some man down at the end of a lateral asks for more water the patrolman will turn a larger head into the lateral, trusting that it will go through to the end where it is wanted. However, if instead of turning more water into the lateral he had gone along down it and cut the other farmers' supplies to what they were entitled to he would have found at the end more water than the man there could possibly use. By such a system as this enormous quantities of water are wasted each year. If the water supply of the farmers were to be cut down in each case to what the contract calls for and an attempt made to accurately measure out this quantity in every instance, a small army of men would be required to handle the distribution and keep the measuring weirs in proper condition. For this reason we believe that better and more satisfactory results in every way would obtain if the matter of dividing the water after being measured out at the heads of the laterals were left to the farmers themselves. The water contracts call for a continuous flow of water, and this method of delivery has almost universally been adhered to, not only under this canal, but on all others in the Yakima Valley. It is believed, however, that farmers here would find it more economical, not only in water but in labor, and in every other way, to adopt methods of rotation in the use of water, as has been done in other parts of the West, where it has been found necessary in order to get the greatest possible good from a limited water supply. Any farmer who has had any experience as an irrigator knows the saving in labor that comes from having plenty of water to work with. A man may spend a week with a small stream in attempting to wet up his alfalfa, while if he could have borrowed equal amounts from two or three of his neighbors on the same lateral the job might have been done in two days. Farmers on a few laterals have learned this and are taking advantage of it by rotating or exchanging water in this way, thereby saving themselves a vast amount of unnecessary labor, but most of them insist upon having their little stream all the time, and if by putting a few laths in a drop or checks of some kind in the lateral they can increase the head of water in their measuring boxes it is the neighbors' loss and their gain. In this way there is constantly more or less strife and friction between neighbors, or farmers and ditch riders, and it will continue to be so as long as the present methods continue and it is necessary to have a lock on every man's measuring box.

To make such a radical change in the method of distribution at the present time, with the old practices so firmly fixed throughout the valley, would be a large undertaking, and one which of necessity would have to come slowly. Such a change would require on the part of the farmers the formation of a large number of local water associations or organizations of some kind for the purpose of regulating the water and dividing it among themselves. Such organizations should be as simple as possible and at the same time be effective. The faculty of organization is not commonly found among farmers, and in this matter some suggestions and assistance would perhaps be needed and appreciated. The first thing necessary, however, in bringing about a reform of this kind is to demonstrate the advantages to be gained by it. This, it seems, could be accomplished in no better way than by inducing the water users on one or two of the more important laterals in each community to adopt rotation in the use of water. In undertaking this plan, getting organized, and started right, farmers should be rendered every possible assistance by this Office and by the management of the canal company. With the value and practicability of this system of distribution fairly demonstrated in a few sections of an irrigated district, it is only reasonable to expect that other progressive irrigators would not be slow in the adoption of similar methods.

While we would recommend a change in the present methods of division from laterals, we believe that the system of measuring all diversions from the main canal and the keeping of careful records of the same should be continued as begun on the Sunnyside canal in 1904, and that other canal companies would profit largely by adopting similar methods. The most serious difficulty to be encountered in most places in connection with the operation of a system of this kind will be to keep weirs in proper condition for reliable measurement. The deposit of silt in the channels above the weirs and also in the laterals below is the worst obstacle to contend with in the Sunnyside district. Above the weir it rapidly reduces the necessary contraction, and by filling up the lateral below, raises the water so as to destroy the required fall. This is a problem which could be solved, however, by cooperation between the farmers and canal companies, if the importance of maintaining such measurements were more fully appreciated by all parties interested, and need not stand as a permanent impediment to such a system of distribution.

APPLICATION OF WATER TO CROPS.

It is practically the universal practice throughout the Yakima Valley to apply water to crops by some form of furrows, varying somewhat in distance apart, depth and length, but in general involving the same principle, the intention being not to flood the surface of the ground but to allow the water to percolate or seep out from the furrows so as to wet the intervening space. These furrows are usually 3 or 4 ft. apart when intended for the irrigation of meadow land, and about 4 to 6 ins. deep. They are made with the marker or lister with the runners the proper distance apart, and formed so as to make the furrows about 4 to 6 ins. wide and about the same depth. The front end of the runners is often fitted with small cultivator shovels. These same markers are sometimes used in cleaning the furrows in the old fields.

When seeding land, it is usual to make the furrows 18 to 24 ins. apart, and after the grass is thoroughly rooted to abandon every other one. The furrows should run on gentle slopes. If given too steep a grade, the water will cut deep gullies into the soil. Not enough attention is given to this matter in many instances, especially in orchards on hillsides. With alfalfa land it does not make so much difference so far as washing is concerned, as the roots of the plants prevent it, but more waste of water results as a rule where it runs so fast.

Water is turned into the furrows from head ditches, usually through spouts 24 ins. to 30 ins. long, made by nailing four pieces of lath together. These are set in the bank of the head ditch, one for each furrow, and arranged so that the water can be shut off by placing a block over the upper end. Flumes are frequently used as a substitute for the earth head ditches, and have holes bored through the sides through which the water is supplied to the furrows. Pieces of lath are usually nailed to the flume so that they may be turned to cut off the flow of any opening, as desired. The flumes for this purpose are usually more satisfactory than the head ditches, and are coming into general favor, being easier to regulate and more economical of water.

While the above methods are the most general, there are a few places where different ones are employed. In parts of the Ellensburg district, where alfalfa and timothy are the principal crops, larger furrows are made across the meadows at distances of a rod or more apart, and then large heads of water turned in, which are allowed to run over and flood the ground. This system is also employed largely throughout the valley on most of the older farms which lie along the river bottoms, where the ground is more or less gravelly and has never been carefully leveled or prepared for other methods of watering. This is a wasteful and primitive method, however, a relic of the time when water was no object and labor was the thing economized.

The contour check system has been used for fifteen or twenty years in the irrigation of meadows on the Moxee farm, where much of the land is flat. Several hundred acres of land have been prepared in this way, the fields being watered by flooding the checks. As so much of the land of the Yakima Valley is rolling, this method cannot be widely adopted, so some form of furrow irrigation will undoubtedly continue to be the general practice.

THE STEAM TURBINE IN VERSE.

Every reader who has read and enjoyed "McAndrew's Hymn," by Kipling, will appreciate the verses below, which we find in the "General Electric Review." It is stated that the first verses have been going the rounds of the English press. The second set were written by Mr. N. C. Ross, of the Cincinnati office of the General Electric Co.

The Receeprocatin' Mon.

By Robert Burns and others, including Gavin Hamilton.

Oh! woesome 'oor that saw the birth
O' turbine thocts in Pairsons' head;
I weesh that I wis aff the earth,
Or else the turbine man wis deid.

I'm a receeprocatin' mon;
I luve tae hear the bearin' bump,
Or yet the piston groan and grunt;
That's religated tae a pump!

This whurligeegin' thing I hate,
For whutnae gude is it tae dae?
Tae sae the fearsome thing gurate
Gars me puir stummuch gang agley.

I wadna care if it had ocht
Tae need a tender fitter's haund;
But it rins sae weel sin it was bocht
I hivna had tae slack a glaund.

I hate the tribe of whurligeegs—
It's jist a pinch o' steam, then "Scat!"
I'm a receeprocatin' mon,
I stan' or fa' wi' Jemmie Watt!

After Using.

(*The Conversion of the "Receeprocatin' Mon."*)

Oh! gladsome 'oor that saw th' birth
O' turbine thochts in Curtis' heid;
He'll knock thae ithers aff th' earth—
I'm fash they weesh that he wis deid.

Lang syne wi' muckle din an' blether
I telt a tale in doleful rhyme;
I tint ma reason a' thegither;
But gat it back, an' mair, wi' time.

I'm no receeprocatin' mon, th' day,
But e'en convairtit haird an' fast;
Th' upright shafts hae come tae stay,
Th' blades stay in; step bearin's last.

It gars me greet tae count th' years
I patched, an' oiled, an' swore an' swat;
Th' "Curtis" gies nae cause for tears—
Dell tak th' tribe o' Jamie Watt!

Tho' ither turbines run or stop,
Or let th' steam straight through them blaw,
Wi' Geordie Curtis an' his top
I'm here tae stan' or here tae fa'!

THE NEW RAILROAD BRIDGE OVER THE PASIG River, near Fort McKinley, P. I., collapsed owing to the breaking of the superstructure, according to press despatches dated Nov. 1. Despatches state that 60 workmen were precipitated into the river, 3 Americans and 20 Filipinos being injured. The estimated damage is reported as $100,000.

A LANDSLIDE OF GREAT MAGNITUDE has been reported from Turkestan, where an earthquake occurred on Oct. 21. Press despatches of Oct. 30 stated that the village of Karatagh in the Province of Bokhara, about 100 miles southeast of Samarkand, was entirely buried. The first reports had it that 15,000 persons had lost their lives; however, more recent reports, dated Nov. 1, have the number of fatalities reduced to 200. The village is situated in a small natural amphitheater surrounded by high mountains, the Karatagh Mountain overhanging the village on one side and the river flowing on the other side. This disaster recalls the great rock slide at Frank, in the Province of Alberta, on April 29, 1903, a complete account of which appeared in Engineering News of June 4, 1903, beginning on page 490. In the Frank disaster the total number killed was 66.

A DYNAMITE EXPLOSION of great severity occurred, on Oct. 30, near Cecil, Pa. Four men were instantly killed and three were injured. The workmen were attempting to thaw out frozen dynamite with the aid of hot cinders on the railway embankment. To facilitate the operation a wood fire was kindled to hasten results. The men were section hands on the Wabash R. R., and one of them, a man of 50, was regarded as an expert handler of explosives.

A peculiar explosion occurred on Oct. 31 in the New York Central R. R. Yards at 46th St., New York City. Fifteen men were grouped about a fire when an explosion occurred in the fire, painfully injuring all of the men. One theory reported is that the heat from the fire exploded a compressed-air pipe which ran beneath.

The magazine of the Petroleum Torpedo Co., near Butler, Pa., exploded and caused a property loss of $25,000, injuring several persons, though none fatally. There were 500 quarts of nitroglycerin in the magazine, and the force of the explosion demolished the factory building of the company, 100 yds. from the magazine. The cause is not known.

INDIA REPORTS THE WORST RAILWAY WRECK of the past week. A brief press dispatch, dated Lahore, Oct. 30, states that in a collision on that date between a passenger and a freight train 13 persons were killed and 11 injured.

Two persons were killed and 27 passengers injured—three seriously—in a head-on collision on the Cincinnati, New Orleans & Texas Pacific Ry., on Nov. 3. A passenger train running at high speed struck a freight train, near Morganville, Ga. The wreckage took fire and burned.

A collision between an Alabama Great Southern R. R. passenger train and a freight train on Nov. 3, near Chattanooga, killed two persons and injured several others.

A freight train on the Baltimore & Ohio R. R. got beyond control on a grade near McMillan, Md., on Nov. 3. Two men were killed when the runaway train overtook and struck another one going more slowly.

One man was killed and two seriously injured in the wreck of a fast train on the Central R. R. of New Jersey on Nov. 3, by a mine cave-in half a mile north of Pittston, Pa. The cave-in occurred as the train was passing the Butler colliery, causing derailment.

An engine and eight cars of a freight train went through a 20-ft. trestle on the Canadian Pacific Ry. at Tattman, P. Q., on Nov. 1. Two trainmen were killed and the rest of the crew escaped by jumping.

An attempt was made to wreck the "Buffalo Express" on the Allegheny Valley division of the Pennsylvania R. R., on the night of Oct. 30, at a point about 16 miles from Pittsburg. The State game warden, Mr. M. F. Alberts, while out gunning for game-law violators, discovered a pile of cross-ties heaped on the track at a point where, had the train struck them, it would have been thrown down a steep embankment into the Allegheny River. He signaled the train with a small electric pocket lamp and stopped it in time. This recalls the epidemic of similar attempts on the Pennsylvania last winter.

The engineers appointed by Prosecuting Attorney Roulison to investigate the recent wreck of an Elberon Ave. car at Cincinnati, in which one man was killed and 59 persons injured, have made their report. It seems that there are two tracks on that portion of the avenue and the cars are operated on the left-hand instead of the right-hand, as is customary, in order that cars running on the desending grade may be as far as possible from the declivity on the south side of the avenue. Briefly, the report indicates that defective track construction and the absence of broken stone or ballast under the crossties, making the track unstable, led to a combined rolling and pitching motion in the fast-running car, which resulted in its leaving the rails. The surface of the macadam between the tracks was reported by the engineers as being fully two inches higher than the tread of the rails, and indications were that the car in pitching had come into violent contact with the high ground between the tracks. The bottoms of the motor casings on the derailed car indicated that such contact had taken place, and this, the engineers state, was a controlling factor in the derailment of the car.

As a result of the serious electric railway wreck near Chicago in August last, in which 18 passengers were killed, seven bench warrants were issued on Oct. 29, from the Coles County Circuit Court for the arrest of officials and employees of the Mattoon City Ry. Co., operating the Charlestown & Mattoon Interurban Line. Directors Underwood, Sampsell and Rose, of Chicago; Federal Judge Peter S. Grosscup, also of Chicago; President E. A. Potter and Supt. Moore, have been indicted, and the motorman of the wrecked car as well. The motorman of the express car, which, it was alleged, had been run between stations without orders, was not indicted. The charge was criminal negligence tending to produce manslaughter.

PANAMA CANAL WORK DURING OCTOBER shows the customary increase over the previous record-breaking month's excavation. The rainfall is now on the increase, being 17.1 ins. in October against 11.9 ins. in September. The records for September and October are summarized as follows:

	Amount in cu. yds. October.	September.
Excavation—		
Culebra	826,891	753,283
Gatun	177,013	123,738
Mindi, Chagres and La Boca	73,813	55,814
Dredging—		
Colon division	409,632	403,842
La Boca division	357,122	144,625
Total from canal prism	1,844,471	1,481,307
Accessory wks. outside canal prism	24,258	36,105
Total excavation for September	1,868,729	1,517,412

The excavation for the month of October, 1906, was 538,254 cu. yds.

RECORD-BREAKING AERONAUTICAL PERFORMances have been achieved recently. A balloon-race which was started from St. Louis, Mo., on Oct. 21, produced the longest flight since the 1,200-mi. flight of de la Vaux in 1900. One of the balloons landed at Asbury Park, N. J., another at Herbertsville, N. J., and others at Dover, Del., Westminster, Md., Patuxent, Md., Armenius Mines, Va., and Caledonia, Ont. The first two points named are about 865 to 875 miles from St. Louis in a direct line. The trip was made in about 40 hrs., and as the actual distance traveled by the leading balloons was probably at least 1,000 miles, their average speed approximated 25 mi. per hr. A dirigible balloon made a trip of record-breaking duration in Germany on Sept. 30. It remained in flight 8½ hrs. continuously. With one motor running its speed was about 20 mi. per hr., while with both motors the speed was about 30 mi. per hr. The wind movement during this run was small.

THE CONDITION OF THE ALLIS-CHALMERS CO. is shown in reports submitted at the annual stockholders' meeting at Jersey City last month. The statement of profits was given as follows:

	For Quarter Ended June 30, 1907. April.	May.	June.	Total.
Gross profit.	$228,660.31	$268,892.81	$282,724.05	$780,277.18
Less general and selling expenses, interest on bonds, etc.	191,261.09	190,474.69	189,183.42	570,919.21
Net profit...	$37,399.22	$69,418.12	$93,540.63	$200,357.97

	For Quarter Ended September 30, 1907. July.	August.	September.	Total.
Gross profit.	$270,461.39	$289,745.30	$292,639.80	$852,836.29
Less general and selling expenses, interest on bonds, etc.	180,449.62	188,045.07	106,431.91	563,926.40
Net profit...	$81,011.77	$101,700.23	$186,207.89	$288,909.89

Of the $15,000,000 bond issue authorized, $12,854,000 have been issued. It is stated that $854,000 of this was to reimburse the company for expenses of the West Allis extensions, being a part of $3,000,000 reserved for specific purposes. It was stated that operating conditions were generally unfavorable on account of the general strike of moulders, the failure of contractors to complete buildings on time, delays in delivery of shop equipment, etc. It was also stated that beginning with October the most of such adverse conditions were overcome and that net earnings were steadily increasing. The company employs about 9,000 workmen with a rate of production of about $2,000 per annum per employee. In the report of the president, Walter H. Whiteside, it was stated that much attention had been given systematizing the work of the Engineering Department, simplifying standard designs, perfecting new designs, etc. Development work was shown as practically completed for the new lines of machinery, such as in gas engines, hydraulic and steam turbines, induction motors, transformers, etc., a larger number of patents were reported issued to the company than ever before. The sales of steam turbines have reached 100,000 KW. capacity in sizes from 500 to 7,500 KW. All other lines of apparatus were shown to be in heavy demand.

MAIL CATCHING AND DELIVERING DEVICES are called for by the United States Post Office Department, and proposals for new devices of this character will be received until Jan. 15, 1908. This step is taken with a view to the improvement of the postal service by securing a more satisfactory method of exchanging mails with moving trains, and also to give to the many inventors who have applied to the Department for consideration of their devices an opportunity to present them in proper form. These devices must be combined catching and delivering appliances, and no device for catching the mail only will be considered. It may be explained that railway companies are required to deliver the mails at all post-offices on their respective lines. If the railways prefer not to make stops at certain points for this purpose, but desire to erect mail catchers or mail cranes at such points, authority is granted by the Post-Office Department, but such devices are paid for and kept in order by the railway company. The Department has in some cases granted applications from the railways for permission to test new devices of this kind, all tests being made at the risk of the company. The Department states that it does not desire to establish too strict a standard in judging new methods of delivery from fast trains, but that it must condemn devices which show any active element of danger in their construction or operation. In the statement sent out by Mr. James T. McCleary, Second Assistant Post Master General, the following points are suggested in regard to the design of mail catching and delivering apparatus:

1. If a receiving apparatus is used on the roadside to receive the mail from the train, it should not be less than 4 ft. 4 ins. from the nearest rail.
2. The car doorway and the car itself should be occupied as little as possible by the device, whether at rest or in operation.
3. The car device should not be limited to operate in only one direction, but should be easily and quickly reversible in the same doorway.
4. Simplicity of design and durability of construction should be constantly kept in view.
5. Inventors should provide for delivery of two or more sacks, and the delivery should contemplate as high as 200 lbs.
6. The device should be adapted to various widths of doors, from 24 ins. upward; it should also permit of being used with either hinged or sliding doors.
7. Provision should be made for the clearance demanded by the law of any state.
8. Every effort should be made for reducing the impact upon pouches caught or delivered to a minimum.
9. The device should be so constructed as not to require the clerk to endanger his life or limbs when adjusting mails for delivery; it should not be necessary for him to expose himself beyond the line of the car door.

THE GASOLINE MOTOR-CARS of the Union Pacific Ry., which have been described and illustrated in our columns, are reported to have proved very satisfactory in service. Nine are now in service and 22 are under construction in the railway company's shops at Omaha, Neb. They have six-cylinder engines, placed transversely at the front end of the car, the cylinders being so arranged as to give three impulses at each revolution of the crank shaft. The engines resemble those used in automobiles, but are built with special reference to railway service and the severe duty imposed upon them. The engine is located on the forward truck of the car, between the bolster and the front or driving axle; it is supported on the side frames of the truck. Eight spiral springs over the truck wheels carry the engine, while the car body is carried on elliptic springs under the truck bolster, thereby eliminating the transmission of vibration to the car. The power is transmitted from the crank shaft to the driving axle through a 5-in. silent running chain on sprocket wheels. Two speeds only are used; the low speed is for starting the car, and the high speed is thrown in after running about a car length. No power is transmitted through gears for the high speed, which is used 95% of the time, everything being locked, making a direct drive from the engine to the axle through the

chain. The engine is reversible and its speed is regulated by throttling the supply of gasoline. Compressed air is supplied through a pump driven by an eccentric on the main shaft of the engine, the air being stored in suitable reservoirs and being used for starting the engine, braking the car, sounding the whistle, and sending the rails. The reverse, throttle and spark advance levers are all conveniently located near the operator's post, as are also all air connections for operating the gear clutches. A straight air-brake system is used, braking with 60-lb. brake cylinder pressure, while the main reservoirs carry from 110 to 150 lbs. of air. (Engineering News, April 6, 1905, p. 355; Dec. 21, 1905, p. 653; May 17, 1906, p. 533; Nov. 22, 1906, p. 536.)

THE RAILWAY LINE THROUGH THE ARLBERG Tunnel under the Tyrolean Alps will be equipped for electric traction. This tunnel is on the main line from Paris to Vienna and is 7 mi. long with steep grades from each entrance to the middle. By the new plans it is proposed to increase the speed of trains 25% and the capacity of the road 50%. The stretch of steam railroad to be converted in this connection is about 140 miles, exclusive of the tunnel. It is proposed to use three-phase, alternating-current locomotives of 3,000 HP. capacity. They will be designed so that when coasting down grade from the centre of the tunnel they will generate current and return to the system about 6% of the energy required to pull the train up the grade. Mr. C. L. de Muralt, Consulting Engineer, of New York City, who was recently appointed Professor of Applied Electrical Engineering at the University of Michigan, has been retained as consulting engineer to the State Railways of Austria and this work will be under his supervision. He has been granted leave of absence from the University of Michigan on this account.

PERSONALS.

Mr. Wm. J. Penhallegon has been appointed Assistant General Manager of the Tennessee Coal & Iron Co., at Birmingham, Ala.

Mr. O. F. Purnell has been appointed District Manager of the Allis-Chalmers Co. at their newly opened office at Deadwood, S. D.

Mr. John F. Reardon has been appointed Superintendent of the electric lines of the Lehigh Valley Transit Co., with office at Allentown, Pa. He succeeds Mr. H. C. Barrow.

Mr. A. F. Church, formerly with the Southern Pacific Co. at New Orleans, has been appointed Superintendent of the Mobile, Jackson & Kansas City Ry., with office at Mobile.

Mr. T. A. Lawson, Assistant General Superintendent of the Chicago & Northwestern Ry., has resigned. He will associate himself with the Harriman lines on the Pacific Coast.

Messrs. Henry A. DeFries and E. E. Northrop, formerly with the American Smelting & Refining Co., at Garfield, Utah, and El Paso, Tex., have opened consulting offices at Calle de Tiburcio 18, Mexico City.

Mr. Robert Lindenthal has resigned as Manager of the Arthur Koppel Co., and will go to Berlin to establish himself as a representative for American manufacturers. He has not entirely severed his connection with the Arthur Koppel Co.

Mr. J. W. Lawler has been appointed Superintendent of the iron foundry department of the St. Charles (Mo.) plant of the American Car & Foundry Co. He was formerly Superintendent of the foundry department of the Madison Car Works.

Mr. F. B. Freeman has been appointed Engineer of Construction of the New York Central & Hudson River R. R., in charge of contract construction work in the exterior zone; his headquarters are at the Grand Central Station, New York City.

Mr. H. H. Russell, Supervisor of the Maryland Division of the Pennsylvania R. R. (who won the $1,200 prize after a recent inspection) has been made Assistant Engineer of the Allegheny Division, at Pittsburg. He succeeds Mr. J. R. McGraw, who takes a furlough.

Mr. C. F. Ludington has been appointed Chief Fuel Supervisor of the Atchison, Topeka & Santa Fe Ry., with headquarters at Topeka. Mr. H. E. Westcott has been appointed to the same position for the Pacific Coast lines of the road, with headquarters at San Bernardino, Cal.

Prof. C. L. de Muralt, M. Am. Inst. E. E. Professor of Applied Electrical Engineering at the University of Michigan, has been appointed Consulting Engineer to the State Railways of Austria, on which there is projected the electrification of about 140 miles of road. He has just returned to this country after a flying trip to Europe to examine the Ariberg tunnel under the Tyrolean Alps, a part of the 140 mi. mentioned.

Mr. John O'Neil, Superintendent of Track Elevation for the city of Chicago, has resigned. He was active in starting the movement for track elevation and, when the work was undertaken, was put in charge of the department. Since Mr. O'Neil took charge there has been elevated about 700 miles of track, at an expense of more than $30,000,000.

Mr. E. A. Westcott has been appointed Superintendent of the car department of the Erie R. R., with Messrs. E. I. Dodds and T. Tracy as Assistant Superintendents. Headquarters are at Meadville, Pa. The positions of Assistant Mechanical Superintendent, Assistant to the Mechanical Superintendent and Assistant Master Car Builder are abolished.

Mr. Wm. H. Schladitz, Mechanical Engineer, Secretary and Manager of the American Dittler Sewage Disposal Co., New York City, is to spend some time in Germany making a study of the advances that have been made in modern sewage disposal in Europe. During his absence Mr. A. C. Hepp, Chief Engineer, will be the executive officer of the company.

Mr. S. T. De La Mater, formerly with the Standard Construction Co., of Chicago, has accepted a position with the General Fireproofing Co., for the present at their general offices at Youngstown, Ohio. Mr. De La Mater is a graduate of Cornell University, Class of 1900, and has had large experience with various engineering and construction companies in reinforced concrete design.

Mr. J. C. Rawn has been appointed General Manager of the Big Sandy Coal & Coke Co., at Marytown and Big Sandy, W. Va., to succeed Mr. J. W. Bigelow, resigned. The general offices of the company are at Syracuse, N. Y. Mr. Bigelow will remain associated with Jewett, Bigelow & Brooks, of Detroit—formerly in control of the Big Sandy Coal & Coke Co.—his headquarters being at Hensley, W. Va.

Obituary.

Jefferson Polk, President of the Des Moines Pioneer Street Ry. Co., died in Des Moines on Nov. 3, at the age of 76.

Edward Rawlins Patterson, of 166 East 67th St., New York City, a retired civil engineer and contractor, died at his home on Nov. 2 at the age of 46.

Sir William George Pearce, Chairman of the Fairfield Shipbuilding & Engineering Co., is reported dead in a despatch dated London Nov. 3. He was born in 1861.

George Orson Clinton, formerly a division superintendent with the Chicago, Milwaukee & St. Paul Ry., and later prominent in railway construction, died at Wilmette, Ill., on Oct. 23.

Edgar H. McCurdy, for nine years connected with the Detroit Lighting Commission—in which he held, at some time, every office, including the presidency—died in Detroit on Nov. 1. He was 57 years of age.

Louis H. Gibson, a prominent architect of Indianapolis, died there on Nov. 2. In addition to having designed many well-known buildings in the State, he had of late years given much attention to road construction. He was a member of the Indiana Engineering Society.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.
Nov. 11-14. Twenty-fifth annual convention at Chicago. Secy., W. E. Emery, C. & A. Ry., Kansas City, Mo.

AMERICAN MINING CONGRESS.
Nov. 11-16. Tenth annual convention at Joplin, Mo. Secy., J. F. Callbreath, Jr., Denver.

AMERICAN CIVIC ASSOCIATION.
NATIONAL MUNICIPAL LEAGUE.
Nov. 19-21. Joint convention at Providence, R. I. Secy., Clinton R. Woodruff, North American Building, Philadelphia.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Fifteenth general meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Convention at Chicago. Secy., C. R. Richards, Columbia University, New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The Secretary advises us that the paper, "Submarines of Battleship Design," in the program of the coming meeting as originally issued, should read "Submarines of Battleship Speed."

AMERICAN CHEMICAL SOCIETY.—At the regular meeting of the New York section to be held at the Chemists' Club, 108 West 55th St., New York City, Friday, Nov. 8, at 8 p. m., Mr. W. L. Dudley will present a paper on "The Effect of Coal Gas on the Corrosion of Wrought Iron Pipe Buried in the Earth."

ENGINEERING SOCIETIES LIBRARIES.—Notice has been received that on and after Wednesday, Nov. 6, the reference libraries of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Institute of Mining Engineers, all in the Engineering Societies Building, at 29 West 39th St., New York City, will be open evenings until nine o'clock on all week-days with the exception of public holidays. These libraries, constituting practically a single library of engineering, and situated conveniently near to the New York Public Library (the new building of the latter not yet being completed, however, nor containing books), are available to members of the societies mentioned above, and to engineers and the public generally, subject to reasonable regulations. The societies desire that strangers wishing to avail themselves of the library privileges bring letters of introduction from members, or obtain cards from the secretaries of the respective societies.

NATIONAL MUNICIPAL LEAGUE.—The program has been issued for the coming joint meeting which the League will hold with the American Civic Association at Providence, R. I., Nov. 19, 20 and 21.

Tuesday afternoon, Nov. 19, at 3 o'clock, President Faunce, of Brown University, will deliver the address of welcome. After replies by the presidents of the two associations, Mr. Clinton R. Woodruff, Secretary of the National Municipal League, will speak on "American Municipal Progress," and Mayor Brand Whitlock, of Toledo, will speak on "National Parties in Local Elections." The evening will be devoted to a smoker for the men, and an informal meeting for the ladies.

On Wednesday morning at 10 a. m., after the election of officers and committee reports, the following papers will be presented, among others on the general subject of Taxation: "Taxation of Public Service Corporations," by Oscar Leser; "Taxation of Railroads," by Henry T. Newcomb, and "Taxation of Business Corporations."

Thursday afternoon will be devoted to exceptional modes of city government, as practiced in cities like Galveston and Des Moines.

Friday morning, at a joint session, Municipal Health and Sanitation will be the general topic. Those who will deliver addresses upon the subject are Dr. Geo. W. Goler, Health Officer of Rochester, N. Y.; Mr. M. N. Baker, President of the Board of Health of Montclair, N. J., and Associate Editor of Engineering News; Dr. Alexander C. Abbott, Chief of the Bureau of Health, Philadelphia, Pa.; Dr. Chas. V. Chapin, Supt. of Health, Providence, R. I., and Dr. C. O. Probst, Secretary of the Ohio State Board of Health, Columbus, O.; Dr. Probst will take as the subject of his address "Municipal Sanitation in its Relation to State and National Government." Other speakers are expected from Chicago, Washington, and Boston.

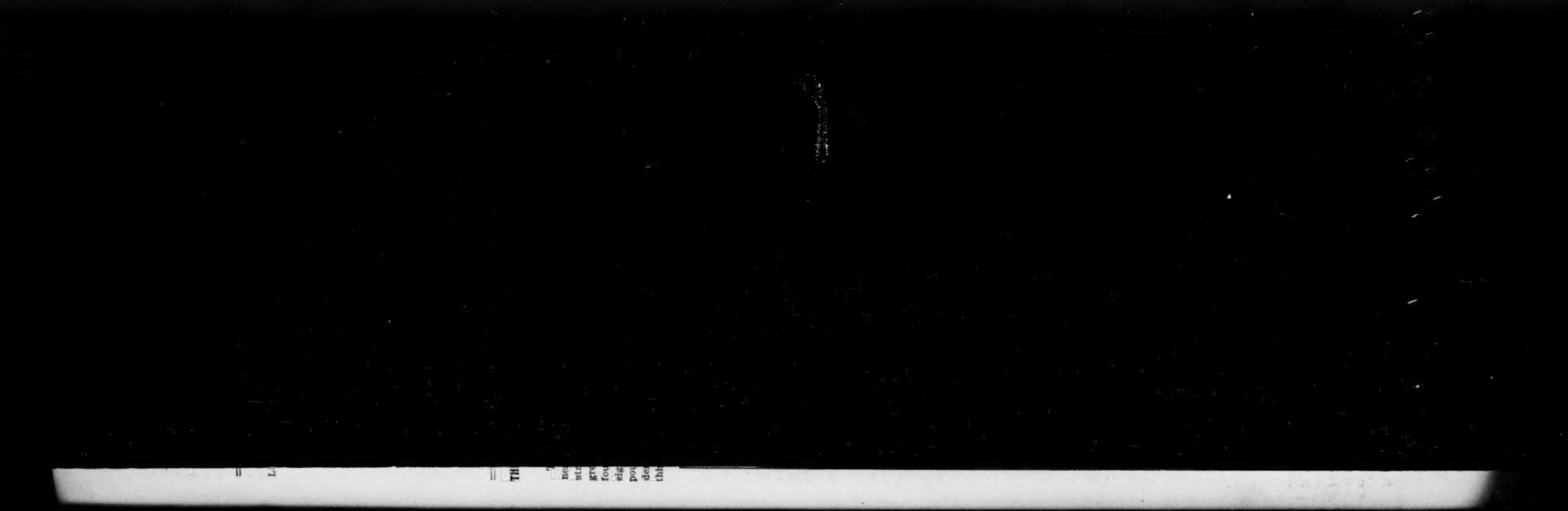
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The 54th annual meeting will be held in the Engineering Societies Building, New York City, Dec. 3 to 6. Sessions begin on Tuesday evening, Dec. 3, at 8:45. After President Hutton's address an informal reception will be held in the auditorium.

After the business of the second session, at 9:30 A. M. on Wednesday, two papers relative to gas power will be presented, one by Mr. F. E. Junge, "The Rational Utilization of Low-grade Fuels in Gas Producers"; another by Mr. J. R. Bibbins, "Duty Test on a Gas Power Plant." A buffet luncheon will be served at one o'clock. Wednesday afternoon will be devoted to an excursion, and the evening is as yet unassigned.

The third session, Thursday morning at 9:30, will be devoted to foundry practice. Papers will be presented on "The Foundry Department and the Department of Engineering Design," by W. A. Bole; "Molding Sand," by A. E. Outerbridge; "Power Service in the Foundry," by A. D. Williams; and "Foundry for Bench Work," by W. J. Keep and Emmett Dwyer.

The papers for the fourth session, Thursday afternoon at 2 o'clock, also devoted to foundry practice, are as follows: "Specifications for Iron, Coke and Method of Testing Output," by Dr. Richard Moldenke (Secy. Am. Fdymen's Assoc.); "Foundry Cupola and Iron Mixtures," by W. J. Keep; "Foundry Blower Practice," by W. B. Snow; "Patterns for Repetition Work," by E. H. Berry; and "Some Limitations of Molding Machines," by E. H. Mumford.

Thursday evening will be devoted to a reception in the foyer of the Engineering Societies Building, at 9 o'clock—to be the main social feature of the meeting.

The fifth session will be held on Friday, Dec. 3, at 9.30 a. m. The following papers will be presented: "The Specific Heat of Superheated Steam," by Prof. Carl C. Thomas (Cornell); "Engine Design Adapted for the Use of Superheated Steam," by Max Toltz; "Power Transmission by Friction Driving," by Prof. W. F. M. Goss; "Cylinder Port Velocities," by J. H. Wallace; and "Industrial Education," by W. B. Russell.

The nominating committee has made the following nominations for officers of the Society for the ensuing year: President, M. L. Holman (Past Vice-President), Consulting Engineer, of St. Louis. Vice-Presidents, Prof. L. P. Breckenridge, Department of Mechanical Engineering, University of Illinois; Fred. J. Miller, formerly Editor of the "American Machinist," and Arthur West, Chief Engineer, Westinghouse Machine Co., East Pittsburg, Pa. Managers, William L. Abbott, Chief Operating Engineer, Chicago Edison Co.; President A. C. Humphreys, of the Stevens Institute of Technology, Hoboken, N. J.; and H. G. Stott, Superintendent of Motive Power, Interborough Rapid Transit Co., New York City. Treasurer, William H. Wiley, of John Wiley & Sons, Publishers, New York City.